
Public and Catholic District School Board Writing Partnerships

Locally Developed Compulsory Credit Course

Course Profile

Science

Grade 10

SNC2L

• *for teachers by teachers*

This sample course of study was prepared for teachers to use in meeting local classroom needs, as appropriate. This is not a mandated approach to the teaching of the course.
It may be used in its entirety, in part, or adapted.

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Acknowledgements – Science

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Course Overview

Locally Developed Compulsory Credit Course: Science Grade 10, SNC2L

Course Description

This course emphasizes reinforcing and strengthening science-related knowledge and skills, including scientific inquiry, critical thinking, and the environmental impact of science and technology, to prepare students for success in everyday life, in the workplace, and in the Grade 11 Science Workplace Preparation course.

Students explore a range of topics, including science in media, interactions of common materials, interdependence of organisms in communities, and using electrical energy.

Students have the opportunity to extend mathematical and scientific process skills and to continue developing their skills in reading, writing, and oral language through relevant and practical science activities.

How This Course Supports the Catholic School Graduate Expectations

The study of science helps students learn to be reflective, critical, and creative thinkers, as well as discerning believers who can apply their knowledge in the spirit of social justice to the world around them. Students are challenged to look at the “big picture” beyond themselves into their school and local community. Students are challenged to make decisions in light of Gospel values and Church teachings to take action, to make an impact, and change things for the greater good. The study of science teaches students to be collaborative contributors to an interdependent team, respecting the rights, responsibilities, and contributions of others. Throughout the course, students experience success, allowing them to build self-confidence in their own abilities to solve problems and deal with authentic situations. These experiences allow students to consider and reflect on the role of science in the workplace, and to learn to find meaning, dignity, fulfillment, and vocation in the work they do.

Course Notes

- This Course Profile is a sample course of study that teachers can use in its entirety, in part, or adapt to meet the specific needs of students in their classrooms.
- This course emphasizes the themes of relationships between the student and his or her environment and how individual choices and actions affect the community in which an individual lives. An individual can make a difference in his or her community.
- This course complements the Locally Developed Compulsory Credit (LDCC) Grade 9 Science course. Teachers should be aware that some students will have completed the Grade 9 (LDCC Science) course, some students will have had unsuccessful experiences in other Grade 9 Science courses, and some students will not have taken a Grade 9 Science course.
- This course has been designed so that students who have not completed the Locally Developed Compulsory Credit (LDCC) Grade 9 Science course will acquire the skills necessary to ensure success in the Grade 11 Science Workplace Preparation course. However, the method of acquiring these skills is different in the LDCC Grade 10 Science course, so that those students who have already taken the LDCC Grade 9 Science course will still be engaged in the learning.

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- Learners in this course have a wide range of scientific knowledge and skills gained in previous courses and other experiences. The activities in Unit 1: Scientific Inquiry: Science in Media are designed to assess this range of scientific knowledge and skills to identify the scientific inquiry skills that students need to develop and/or extend in order to have a solid foundation for learning the concepts and skills presented in subsequent units. The units that follow address the specific concepts and skills related to the subjects Physics, Biology, and Chemistry.
 - Although it is suggested that the Scientific Inquiry: Science in Media unit always be delivered first, the timing of the other units may vary depending on when the course is offered. During the Biology unit, teachers and students are encouraged to go outside of the classroom to observe ecosystems. If this course is offered in a non-semestered school, or in Semester one, it is most appropriate to study Biology as the second unit. If the course is offered in Semester two, it is most appropriate to study Biology as the fourth unit. It is recommended that Chemistry always be Unit 3 because the skills developed in the Chemistry unit are essential for the final evaluation in Unit 5. Therefore, Biology and Physics would be Units 2 and 4, depending on the time of year.
 - Expectations are clustered into units based on common themes. Each unit is subdivided into more than one cluster of expectations so that the amount of material under study is of reasonable size. Some expectations appear several times in the document so that students have multiple opportunities to meet the expectation and demonstrate their achievement and be well prepared for the Grade 11 Science Workplace Preparation course and their roles in society and the workplace.
 - Unit 5: Community Action Plan represents the final evaluation and must be a consideration in the planning of the remaining units. It is intended that students be introduced to the final task well before it is begun, and that some of the preparation for the final task take place during the other units. Each unit provides practice in skills that are required to complete the final task toward the end of the course.
 - Teaching/learning activities were designed with the nature of the adolescent learner in mind. Emphasis was placed on the needs of students to experience success; to engage in hands-on, practical, and relevant activities; to develop and practise essential skills; to be reflective about their learning; and to be well supported in their efforts to learn and grow.
 - Literacy strategies are embedded throughout the Course Profile to help students gather, interpret, and integrate information; communicate effectively in a variety of forms; and use before-, during-, and after-reading strategies to improve reading comprehension of scientific and technical texts. Forms of communication include oral, written, and graphical, with a particular emphasis on oral communication as the precursor to the further development of reading and writing skills. See Appendix A: Strategies for Literacy Connections in the Science Classroom.
 - Mathematical literacy is an important component of science education and has been included, where appropriate. Skills such as estimation and measurement, use of appropriate formulae, collection and analysis of numerical data, and interpretation of graphical data are emphasized.
 - Activities are designed to allow students to practise the Essential Skills that they require for success in the workplace. For example, the types of documents they handle in this course will reflect the types of documents they are likely to use in different workplaces. The Resources list provides suggestions of sources for these authentic documents.
 - Wherever possible, opportunities to provide student choices based on personal interest have been incorporated into the activities. Teachers may need to develop strategies to assist students in identifying areas of personal interest and in making appropriate choices.
 - Teachers of the LDCC Science course are urged to collaborate with teachers of the LDCC English and Mathematics courses. Many opportunities for curriculum integration exist among these three courses. In addition, teachers are encouraged to consult with the teacher(s) of the Grade 9 Locally Developed Compulsory Credit Science course in previous years or semesters who may be able to provide portfolios from students who have taken the Grade 9 course.

Health and Safety

Teachers are responsible for ensuring the safety of students during classroom activities and for teaching students to assume responsibility for their own and others' safety. They must model safe practices and communicate safety expectations to students in accordance with school board and ministry policies. This concern for safety in science requires that students demonstrate:

- knowledge about the materials, tools, processes, and procedures used in science;
- skill in performing tasks in the laboratory;
- knowledge about health and safety concerns and about the care of living things (plants and animals) that are brought into the classroom;
- concern for the health and safety of self and others.

Students demonstrate the knowledge, skills, and habits of mind required for safe involvement in science when they, for example:

- maintain a well-organized and uncluttered work space;
- carefully follow the instructions and example of the teacher;
- identify possible health and safety concerns;
- follow established safety procedures;
- suggest and implement appropriate safety procedures in new situations;
- comply with Workplace Hazardous Materials Information System (WHMIS) legislation.

The health and safety of teachers and students must be of paramount importance when conducting laboratory activities. Teachers must provide specific instructions and cautions regarding the safe handling, storage, and disposal of materials and safe handling and storage of equipment used in each activity. See *Stay Safe*, the STAO safety booklet for suitable safety rules for students.

Units: Titles & Time

Unit 1	Scientific Inquiry: Science in Media	12 hours
Unit 2	Biology: Living Together	26 hours
Unit 3	Chemistry: Interactions of Common Materials	26 hours
Unit 4	Physics: Using Electrical Energy	26 hours
Unit 5	Community Action Plan	20 hours

Unit Overviews

Unit 1: Scientific Inquiry: Science in Media

Time: 12 hours

Unit Description

Scientific literacy is critical for students in an increasingly technological and scientific world. Students are bombarded with science-based claims and a solid base of scientific inquiry skills enables them to distinguish between fact and opinion and to understand media bias in order to make informed decisions. Students are exposed to a variety of opinions and messages.

The scientific inquiry and critical thinking skills developed in this unit are revisited throughout the course and ensure students prepare for success in the final unit evaluation. Media and scientific literacy are emphasized throughout the unit, enabling students to question the presentation of science information in the media.

Students focus on reviewing the laboratory and investigation skills required to evaluate science-based claims through experimental research. Students examine various modes of science-related media and learn to analyse media for the messages portrayed and then investigate a science-related issue through media-based research. Throughout the unit, they practise the Essential Skills of reading text, document use, numeracy, oral communication, computer use, decision making, and working with others.

Unit Overview Chart

Activity	Learning Expectations	Assessment Categories	Focus
1.1 Investigating Media Claims Experimentally	SIMV.02, .03, SIM2.01, 2.04, 3.01, 3.02 CIMV.02, CIM2.01 CGE5a	Inquiry Communication	Working in groups, evaluate some science claims in the media through experiments
1.2 Understanding Media	SIMV.01, .03, SIM1.01, 1.02, 1.03, 3.04 CGE2b, 2c, 3b	Knowledge/ Understanding Inquiry Making Connections	Deconstructing media for audience and purpose
1.3 Investigating Science Issues using Media- Based Research	SIMV.02, .03, SIM2.02, 2.03, 2.04, 3.02 CGE2e, 3f, 4f	Inquiry Making Connections	Evaluating science claims in the media through media-based research

Unit 2: Biology: Living Together

Time: 25 hours

Unit Description

Living in a community presents challenges for and benefits to all living things – plants, animals, and humans. By observing examples from nature, students make connections to their role as responsible members of the world community.

Students are introduced to the biological concept of population, focusing on the benefits and challenges of organisms of the same species living together. They investigate and report on the problems that arise when populations of microscopic organisms become overcrowded. Through the study of a pond, field, or other biological community, students see that natural populations do not exist in isolation and relate their observations to human populations. Students refine laboratory skills while investigating population growth and structure using larger organisms. These investigations become the basis for the school-based action plan developed in Unit 5 and in the Final Course Evaluation.

Unit Overview Chart

Activity	Learning Expectations	Assessment Categories	Focus
2.1 Benefits and Costs of Living Together	BLTV.01, .02, BLT1.01, 1.02, 1.03, 1.04, 2.06 SIMV.02, SIM2.02, 2.04 CGE2a, 2b	Knowledge/ Understanding Inquiry Communication Making Connections	Benefits and challenges of living in communities
2.2 Investigating Populations of Microscopic Organisms	BLTV.02, .03, BLT2.01, 2.03, 2.06, 3.01 SIMV.03, SIM3.04 CIMV.02, CIM2.01 CGE4f, 5a, 7i	Inquiry Communication Making Connections	Microscopic investigations of population diversity and overcrowding within a community

Activity	Learning Expectations	Assessment Categories	Focus
2.3 Investigating Populations of Macroscopic Organisms	BLTV.01, .02, BLT1.02, 1.03, 2.02, 2.05, 2.06 SIMV.02, SIM2.04 PEEV.02, PEE2.05 CGE2b, 3e, 4f	Knowledge/ Understanding Inquiry Communication	Macroscopic investigations/research into “communities”
2.4 School Environmental Issue Action Plan	BLTV.01, .02, .03, BLT1.02, 2.04, 3.01, 3.02 SIMV.01, .02, SIM1.01, 1.02, 1.03, 2.02 CIMV.02, CIM2.01, 2.05 PEEV.02, PEE2.05 CGE2a, 2b, 2c, 2d, 7i, 7j	Inquiry Communication Making Connections	Propose and communicate an action plan to address a school-based environmental issue

Unit 3: Chemistry: Interactions of Common Materials

Time: 26 hours

Unit Description

Using the various forms of media, students develop an awareness of the multitude of common chemical compounds found in everything they use and consume in their everyday lives. They understand and investigate the interactions among compounds and practise literacy skills by appropriately communicating the information learned. Students classify chemicals found in common materials through examination of Household Hazardous Product symbols (HHPs) and Workplace Hazardous Materials Information System (WHMIS) labels found at home, at work, and in the laboratory. They learn and apply different classifications of physical and chemical interactions through research and laboratory activities. Students examine factors that affect rates of chemical and physical interactions qualitatively, through several laboratory investigations. Investigative skills are revisited in the culminating activity in Unit 5 through the research of environmental impacts. In the unit evaluation, students plan, conduct, and communicate the results of an investigation that compares both synthetic and natural materials and their effects on the environment.

Unit Overview Chart

Activity	Learning Expectations	Assessment Categories	Focus
3.1 Understanding of Chemicals Found in Everyday Products	CIMV.01, .02, CIM1.01, 1.02, 2.01, 2.05 SIMV.01, .02, .03, SIM1.01, 1.03, 2.03, 3.04 CGE2b, 2c, 2d, 2e	Knowledge/ Understanding Inquiry Communication Making Connections	Classification of common chemicals
3.2 Physical and Chemical Interactions	CIMV.01, .02, .03, CIM1.03, 2.01, 2.02, 2.03, 3.01 SIMV.02, SIM2.02, 2.04 CGE5a, 7i	Knowledge/ Understanding Communication Making Connections	Physical and chemical interactions
3.3 Rates of Chemical and Physical Processes	CIMV.01, .02, CIM1.04, 2.04, 2.05 SIMV.02, .03, SIM2.01, 2.03, 2.04, 3.01, 3.03 CGE3c	Inquiry Communication Making Connections	Rates of chemical and physical processes

Activity	Learning Expectations	Assessment Categories	Focus
3.4 Experimental and Media-based Research	CIMV.03, CIM3.01, 3.02, 3.03 SIMV.03, SIM3.01, 3.02 CGE2b, 2e, 3c, 3f, 4f, 5a	Knowledge/ Understanding Inquiry Communication Making Connections	Student-designed investigation

Unit 4: Physics: Using Electrical Energy

Time: 26 hours

Unit Description

The growing demand for electrical energy has important implications for all communities, influencing quality of life and the state of the environment. Students increase awareness and understanding of issues linked to the generation and use of electrical energy. The activities emphasize the skills of collaboration, safe investigation, numeracy, media literacy, and communicating with an audience. The first activity, which continues throughout the unit, helps students to build an understanding of the terminology used in the study of Electrical Energy. Students gain an awareness of our reliance on electrical energy and an understanding of the energy conversions associated with the use of electricity. They compare electrical appliances and simple machines with respect to energy, power, current, and potential difference through laboratory investigations. Students design and build a device that generates electrical energy and make modifications to increase its output. They expand their understanding of stewardship and their responsibility as energy conservers by researching methods of generating electricity; analysing social, economic, and/or environmental implications; identifying consumption patterns; and designing and implementing a plan to reduce the consumption of electrical energy.

Unit Overview Chart

Activity	Learning Expectations	Assessment Categories	Focus
4.1 Physics Terminology	PEEV.01, PEE1.02 CGE2b, 2d	Communication	Physics terminology
4.2 Using Electricity	PEEV.01, .02, PEE1.02, 1.03, 1.04, 2.04 SIMV.02, SIM2.04 CGE5a	Knowledge/ Understanding Communication	Electrical Appliances: Examining the form of energy produced; calculating energy use based on power and time
4.3 Practical Electricity	PEEV.01, .02, PEE1.02, 1.03, 2.03, 2.04 CIMV.02, CIM2.05 SIMV.01, .03, SIM1.03, 3.03 CGE2c	Knowledge/ Understanding Inquiry Communication	Practical Electricity: Designing, building, and modifying an electrical device to increase electrical energy production
4.4 Generating Electricity	PEEV.01, .02, .03, PEE1.01, 1.02, 1.04, 2.01, 2.05, 3.01, 3.02 BLTV.02, BLT2.06 SIMV.02, SIM2.02 CGE3f, 7i, 7j	Knowledge/ Understanding Inquiry Communication Making Connections	Generating Electricity: Researching methods of generating electricity, analysing their impact, and designing a plan to reduce consumption

Unit 5: Community Action Plan

Time: 20 hours

Unit Description

Environmental concerns arise from the growing demand for electrical energy and the increased generation of electric power. Students demonstrate the skills and knowledge gained in prior units through the generation of an action plan and public awareness campaign. They learn personal accountability for the state of the environment and come to understand that their actions impact their community.

Students perform a variety of laboratory investigations into environmental concerns related to generating electricity, e.g., effects of acid rain, oil spills, greenhouse gases, particulate matter, and battery disposal. These investigations combine safe laboratory procedures; posing questions; collecting, organizing, and analysing data; and drawing conclusions. Using a variety of resources, students research the environmental effects of electrical power generation by chemical means on communities and environmentally friendly alternative power generation. The experimental and media-based research lead to the development, presentation, and implementation of a community-based action plan. This task addresses literacy and numeracy through media-based research, problem solving, communication, and presentation of the action plan and media campaign. Students are given opportunities for self-assessment and to receive teacher and peer feedback to improve their final product.

Unit Overview Chart

Activity	Learning Expectations	Assessment Categories	Focus
5.1 Experimental-Based Research	CIMV.02, .03, CIM2.01, 2.02, 3.01 BLTV.02, BLT2.04 SIMV.02, SIM2.04 PEEV.03, PEE3.01 CGE3b, 3c, 3d, 3f	Inquiry Communication Making Connections	Investigating environmental concerns
5.2 Media-Based Research	BLTV.02, BLT2.04 SIMV.02, SIM2.02, .03 PEEV.02, .03, PEE2.01, 3.01 CGE4f	Inquiry Communication Making Connections	Researching environmental implications of generating electricity and alternative methods of generating electricity
5.3 Action Plan and Public Awareness Campaign through Media	SIMV.01, .02, .03, SIM1.02, 1.03, 2.04, 3.04 CIMV.03, CIM3.03 BLTV.03, BLT3.01 PEEV.02, .03, PEE2.05, 3.02 CGE5d	Inquiry Communication Making Connections	Design and create an action plan and a media piece for a Public Awareness Campaign

Teaching/Learning Strategies

The goal of this course is to foster a safe and inviting classroom where students will gain confidence in their abilities by experiencing success. Many of the teaching and learning strategies suggested assist in the development of routines, provide opportunities for feedback and reflection, and aid students in gaining a repertoire of essential skills and knowledge.

Strategies include:

- Use of flexible groupings
- Opportunities for talk and discussion
- Practical, relevant, authentic tasks
- Interactive, hands-on activities
- Use of manipulatives and models
- Opportunities for metacognition and reflection
- Expanding the learning environment beyond the classroom
- Inviting the community into the classroom
- Use of assistive technology
- A focus on skill development
- Inquiry problem-based learning
- Age- and skill-level appropriate resources
- Use of scaffolded supports
- Assignments based on personal choice
- Ample opportunities for practice with feedback
- Use of portfolios to collect and organize student work
- Use of Operator's Licences to track skill development
- Use of Scientific Terminology Licences to build new vocabulary
- Dry-run rehearsals prior to lab activities
- Use of authentic workplace documents and experiences
- Collection, organization, presentation, and analysis of data
- A variety of presentation formats, including graphic organizers, posters, audio, video, demonstrations, oral and written formats
- Safe use of scientific tools and equipment
- Print, electronic, community, and audiovisual resources
- A focus on media-based research, in addition to experiment-based research
- Opportunities to plan, design, carry out, and modify investigations

Assessment & Evaluation of Student Achievement

Seventy percent of the grade will be based on assessments and evaluations conducted throughout the course. Thirty percent of the grade will be based on a final evaluation as defined in *The Ontario Curriculum Grades 9 to 12 Program Planning and Assessment 2000*. The term *assessment* used in the activities refers to feedback to students to improve their learning. The term *evaluation* refers to data used by the teacher to determine a student's report card grade. In Units 1 through 4, the term evaluation refers to data used by the teacher to determine the seventy percent of this grade assigned to course work. The evaluations referred to in Unit 5: Community Action Plan combine to form the final thirty percent of a student's report card grade.

In each unit, there are extensive supports given for assessing and evaluating student learning during the activities. Throughout each stage of the activities, there are suggestions for providing immediate and ongoing feedback to move students forward in their learning. Teachers are encouraged to use their professional judgement and their knowledge of the students in selecting opportunities, strategies, and tools for this process.

This Course Profile is structured around assessments that allow students to develop and demonstrate personal growth. Diagnostic assessment forms the major focus of Unit 1 and is incorporated into the beginning of Units 2, 3, and 4. The results of the diagnostic assessment should be used to inform the remainder of the unit. Frequent, ongoing feedback is provided to students throughout the course. This feedback comes from a range of self-, peer, and teacher assessments built into the activities. Students are provided with opportunities and a variety of personal choices in how to demonstrate their learning. Students are only evaluated once they have had opportunities to receive feedback. In order to build in success and make the tasks more manageable, a culminating task has been suggested to evaluate each activity, rather than an end-of-unit evaluation. The evaluation data collected during Units 1 through 4 are combined to form seventy percent of a student's report card grade. As well, each activity evaluation is designed to provide practice in the components that must be demonstrated in the final thirty percent evaluation represented by Unit 5.

In Unit 5, the Community Action Plan describes the tasks that students perform to demonstrate their achievement of the expectations of this course. This evaluation takes the form of a series of activities, which are performed toward the end of the course. The data collected in these evaluations are combined together to form the final thirty percent evaluation for this course. Throughout Units 1 through 4, students have had an opportunity to practice the research and investigation skills needed for formulating the plan. In the Biology unit, the skill emphasis is on formulating action plans. In the Chemistry unit, the skill emphasis is on scientific investigations, and the Physics unit emphasizes skills in research.

Appendix C is a sample rubric that teachers can use or modify to determine students levels of achievement during the experimental investigations in the units.

A theme running throughout the assessment of the LDCC Grade 10 Science course is demonstrating mastery of the use of specific tools, or skill sets, e.g., the use of WHMIS symbols. To make connections to the workplace skills students earn an Operator's Licence in each area – electricity, equipment handling, microscope use, scientific terminology, and health and safety. These licences might be collected in a portfolio so that students can see the development of their skills throughout the course and could be used as evidence that they have mastered the skills. In each unit, a minimum of one Licence is required. Students can earn a Licence when a minimum of Level 3 achievement is demonstrated. Where appropriate, e.g., WHMIS, where the industry standard is 100% achievement, this minimum achievement can be modified. Students who are unsuccessful in obtaining their Licence on the first attempt should be given additional opportunities to earn a Licence as their skills progress.

Building an Effective Rubric

- Determine a cluster of expectations to be assessed and/or evaluated.
- Decide how the students will be expected to demonstrate achievement of these expectations (i.e., build a performance task).
- Connect the selected expectations to one or more of the Achievement Chart categories. **Note:** The verb is often an indicator for connecting the expectation to a particular category.
- Develop criteria for each expectation that identify the aspects of student performance that are to be assessed and/or evaluated (i.e., the "look fors").
- Indicate the required characteristic for each criteria (e.g., clear, effective, accurate, appropriate).
- Provide qualifiers for each of the four levels of achievement (i.e., limited, some, considerable, high degree).

Accommodations

Accommodations refer to the teaching strategies, supports, and/or services that are required in order for a student to access the curriculum and demonstrate learning: **Instructional Accommodations** refer to changes in teaching strategies that allow the student to access the curriculum. **Environmental Accommodations** refer to changes that are required to the classroom and/or school environment. **Assessment Accommodations** refer to changes that are required in order for the student to demonstrate learning. Because of the wide range of students in these courses, a range of accommodations needs to be planned for and provided to students. Students who have an IEP are entitled to the accommodations specified in these plans.

Examples of Accommodations

Instructional Accommodations	Environmental Accommodations	Assessment Accommodations
<ul style="list-style-type: none"> • Buddy/peer tutoring • Note-taking assistance • Duplicated notes • Contracts Reinforcement incentives • High structure • Partnering • Ability grouping Augmentative and alternative communications systems • Assistive technology, such as text-to-speech software • Graphic organizers • Non-verbal signals • Organization coaching • Time-management aids • Mind maps • Increased breaks • Concrete/hands-on material • Manipulatives • Tactile tracing strategies • Gesture cues • Dramatizing information • Visual cueing • Large-size font • Tracking sheets • Colour cues • Reduced/uncluttered format • Computer options • Spatially-cued formats • Repeat information • Reword/rephrase information • Allow processing time • Word retrieval prompts • Taped texts • Pictures to illustrate scientific terms 	<ul style="list-style-type: none"> • Alternative workspace • Strategic seating • Instructor proximity • Reduced audiovisual stimuli • Study carrel • Minimize background noise • Quiet setting • Use of headphones • Special lighting • Assistive devices or adaptive equipment • Large-scale models and/or manipulatives 	<ul style="list-style-type: none"> • Extended time limits • Verbatim scribing • Oral responses, including audiotapes • Alternative settings • Increased breaks • Assistive devices or adaptive equipment • Prompts to return student's attention to task • Augmentative and alternative communications systems • Assistive technology, such as speech-to-text software • Large-size font • Colour cues • Reduced/uncluttered format • Computer options • Processing time allowed • Large-scale models and/or manipulatives

Adapted from: OSSLC Course Profile, Grade 12 Open (OLC4O), 2003

Resources

The URLs for the websites were verified by the writers prior to publication. Given the frequency with which these designations change, teachers should always verify the websites prior to assigning them for student use.

Units in this Course Profile make reference to the use of specific texts, magazines, films, videos, and websites. Teachers need to consult their board policies regarding use of any copyrighted materials. Before reproducing materials for student use from printed publication, teachers need to ensure that their board has a Cancopy licence and that this licence covers the resources they wish to use. Before screening videos/films with their students, teachers need to ensure that their board/school has obtained the appropriate public performance videocassette licence from an authorized distributor, e.g., Audio Cine Films Inc. Teachers are reminded that much of the material on the Internet is protected by copyright. The copyright is usually owned by the person or organization that created the work. Reproduction of any work or substantial part of any work on the Internet is not allowed without the permission of the owner.

Science Resources

Print

Grace, Eric. *SCIENCEPOWER 10TM*. Toronto: McGraw-Hill Ryerson Limited, 2000. ISBN 0075603632

Haduch, Bill. *Science Fair Success Secrets*. New York: Dutton Children's Books, 2002. ISBN 0-525-46534-0

Ritter, Robert, Donald Plumb, Frank Jenkins, Hans van Kessel, and Alan Hirsch. *Nelson Science 10*. Toronto: Nelson Thomson Learning, 2000. ISBN 0176075011

Science Teachers of Ontario. *Stay Safe*. Toronto: STAO, 2002. ISBN 1-894592-22-0

Sci-Tech Ontario. *Real Science: Using Projects to Engage Students and Meet the Goals of the Ontario Curriculum, Grades 9 to 12*. First Edition. Ontario: Sci-Tech Ontario, 2003.

Software

Smart Ideas. Ministry-licensed OSAPAC – Graphic organizers

TABS Plus. Computer program that designs and prints out nets (blueprints) to design and build three-dimensional shapes of your choice

Websites

Access Excellence – www.accessexcellence.org

American Chemical Society – www.chemistry.org

Bill Nye the Science Guy – www.nyelabs.com

Centre for Environmental Education Web Resources – <http://weblinks.schoolsgogreen.org>

Cleaner and Greener: An Energy and Environment Program – www.cleanerandgreener.org

Community Learning Network – www.cln.org

David Suzuki Foundation – www.davidsuzuki.org

Discovery.com – <http://www.discovery.com>

Green Teacher – www.greenteacher.com

Nature Serve Explorer – www.natureserve.org/explorer

Resources in Science – www.cln.org/subjects/science.html

Science.ca – www.science.ca/home.php

Science Education Resource Page – <http://educ.queensu.ca/~science/>

Science Teachers' Association of Ontario – www.stao.org

Sci-Tech Ontario – www.scitechontario.org

The Why Files – <http://whyfiles.news.wisc.edu>

Science Literacy Resources

Print

- Allen, Janet. *Words, Words, Words*. Portland, ME: Stenhouse, 1999. ISBN 1571100857
- Barton, Mary Lee and Clare Heidema. *Teaching Reading in Mathematics*. Aurora, CO: McREL, 2000.
- Barton, Mary Lee and Deborah L. Jordan. *Teaching Reading in Science*. Aurora, CO: McREL, 2001. ISBN 1893476030
- Beers, Kylene. *When Kids Can't Read What Teachers Can Do*. Portsmouth, MA: Heinemann, 2003. ISBN 0867095199
- Bennett, Barrie and Carol Rolheiser. *Beyond Monet*. Toronto, ON: Bookstation, 2001. ISBN 0969538839
- Daniels, Harvey and Steven Zemelman. *Subjects Matter: Every Teacher's Guide to Content-Area Reading*. Portsmouth, NH: Heinemann, 2004. ISBN 0325005958
- Evetts, Julian. *Document Literacy: A Guide for Workplace Educators and Instructors*. Burnaby, B.C: SkillPlan, BC Construction Industry Skills Improvement Council, 1996. ISBN 0969728891
- Harvey, Stephanie and Anne Goudvis. *Strategies that Work: Teaching Comprehension to Enhance Understanding*. Markham, ON: Pembroke, 2000. ISBN 1571103104
- Sejnost, Roberta and Sharon Thiese. *Reading and Writing Across Content Areas*. Glenview, IL: Skylight, 2001. ISBN 157517362X
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Appendix A: Strategies for Literacy Connections in the Science Classroom

The following strategies are suggestions that science teachers can use to support students in building on their oral communication, reading, and writing skills.

Oral Communication

We learn language – its words, structure, and meanings – orally. Students may need to hear the correct terminology and phrasings many times before they comprehend meaning, or are able to use words and phrases themselves in conversation.

To assist students in gaining skills in oral language as they engage in meaningful conversation about science, teachers can:

- model correct scientific terminology;
- stage conversations that require students to use scientific terminology and engage in critical thinking (*Think Literacy*, pp. 151-186).

Questioning

Many questions asked of science students are directly stated in text. Answering indirect questions requires students to combine their prior knowledge with information from the text. Students should be able to connect their personal lives to the text they are reading in Science.

- Science teachers can use questions requiring students:
 - to understand direct ideas and information;
 - to understand indirect ideas and information; and
 - to make connections between personal experience and the reading
- Science teachers can teach students to infer (*Think Literacy*, pp. 40-43; Beers, pp. 165-171);
- Science teachers can model and have students use a strategy such as The Question-Answer Relationship Strategy to understand questions asked and to pose questions for others (Sejnost and Thiese, pp. 13-16; Barton and Jordan, pp. 117-119).

Reading

The purpose often determines how a reader approaches a text, e.g., in some cases, they need to skim and pick out only key words; in other cases, they may need to understand a small portion of the text thoroughly.

In the workplace and at home, students read informational and graphical text containing technical terms. In the science classroom, there are multiple ways to engage students in reading for information, reading to challenge thinking, and reading to consolidate learning

Science teachers can:

- give students a purpose for the assigned reading and ask them to suggest the strategy they will use;
- teach students to define their own purpose for reading by modelling, e.g., turn headings into questions that will be answered in the text; skim text and predict questions the text might answer.

Before-, During-, and After-Reading Strategies

Students can develop a number of before-, during-, and after-reading strategies as they interact with texts in Science. To prepare for reading, students can skim for terminology, text features, and structure; recall prior knowledge to connect to the text; and determine a purpose for reading. During reading, they engage with the text. After reading, they reflect, connect the text to their own lives, and review to consolidate their learning. Most of the references are structured around these three important stages of reading.

Appendix A: Strategies for Literacy Connections in the Science Classroom (continued)

Some examples follow:

	Teaching Strategies	Student Strategies
Before Reading	<ul style="list-style-type: none">• Anticipation Guide• Word Sorts, Games• Set Purpose• Know/Want to Know/Learned Chart (KWL), Directed Reading/Thinking Activity (DR/TA)• Vocabulary Development• Graphic Organizer• Group Discussion	<ul style="list-style-type: none">• Turn headings into questions• Skim for unfamiliar terminology to look up, text features, signal words for patterns• Think about prior knowledge• Set purpose (KWL)
During Reading	<ul style="list-style-type: none">• Pair Reading• Anticipation Guide• Graphic Organizer• Vocabulary Development• KWL, DR/TA	<ul style="list-style-type: none">• Engage with text• Answer/ask questions• Think aloud• Complete graphic organizer• KWL
After Reading	<ul style="list-style-type: none">• Question-Answer Relationships (QAR)• Group Response/Debate Activity• Discussion• KWL, DR/TA	<ul style="list-style-type: none">• Reflect, Reread, Retell• Complete learning log• Think about how text connects to self• KWL

Sources: Barton and Jordan; Burke, Klemp and Schwartz; *Think Literacy*.

Technical Terminology

Scientific or technical terms often pose difficulty for learners because:

- technical terms are not used frequently in everyday language;
- terms may not be understood easily from context;
- some words may have different meanings in science as opposed to everyday language;
- the terms used in the workplace may be different from those used in science.

Research indicates that we must hear words at least six times in context before we can determine and recall its meaning. Some terms are critical and require a deep understanding to comprehend text. Students may require only a surface understanding of other technical terms and still be able to read and extract meaning.

Science teachers can:

- identify a small number of critical terms for each unit and work with them frequently using a variety of strategies, e.g., word webs;
- select terminology in a text that may be problematic for students;
- provide glossaries with clear explanations of terms;
- post key terminology in the classroom, e.g., word walls, word trees: include pictures and labels;
- teach students how to recognize when terminology is a block to reading, and use strategies to help themselves.

Appendix A: Strategies for Literacy Connections in the Science Classroom (continued)

1. Predict the Meaning of Unfamiliar Words Encountered in Text

In scientific or informational texts, students can look for clues such as:

- definitions enclosed in parentheses;
- bold words indicating a glossary entry;
- italics indicating a definition may be located elsewhere;
- definitions/explanations in footnotes;
- definitions/explanations in graphs and charts or pictures;
- definitions, examples, descriptions, clarification, comparisons, and elaborations within the text following the new word itself (Allen, 1999; Beers; *Think Literacy*, pp. 34-39);
- using prefixes, suffixes, and roots to predict the meaning of words (Allen, 1999; Beers, Burke, Klemp and Schwartz, pp. 758-765).

2. Reflect on How Well They Know the Words

Students can:

- work in groups with a list of words they work through together as they read a passage;
- respond to a list of words using a strategy such as the 1, 2, 3 method: 1) Words I am very familiar with; 2) Words I have heard before and think I know the meanings of; 3) Words I have never heard before. This is useful as a diagnostic before-reading exercise and then at the end of a unit, students may discuss vocabulary and update their numbers;
- use a Knowledge Chart. Before reading they fill in what they know about a critical scientific term. After reading, they fill in what they learned about the term and complete a graphic organizer to consolidate the learning.

3. Work with Words in a Collective Sense

To reinforce their understanding of technical terms, students can:

- solve word puzzles and games that use the technical terms needed for the unit;
- group technical vocabulary into categories, e.g., units, quantities, or sort them using a Venn diagram (Barton and Jordan);
- create and refine concept maps and use them as organizers for the words contained in a unit (Barton and Jordan, 2001; *Think Literacy*, 2003; Bennett and Rolheiser, 2001; Strong et al., 2002);
- complete statements by selecting recently learned terminology for the blank spaces, and justify their response.

4. Graphic Organizers

These organizers help students construct layers of understanding about the critical term or series of terms they are studying.

Examples:

- Semantic Feature Analysis
- Semantic Mapping
- The Frayer Model
- Concept of Definition
- Analogies: Similarities and Differences Chart
- Four-Dimensional Study
- Content-Context Experience
- Concept Ladder

Appendix A: Strategies for Literacy Connections in the Science Classroom (continued)

- Vocabulary Graphics (a student-prepared card with the word and its definition in the centre and in each of the four corners: an antonym, a synonym, a sentence, and an illustration)

5. Matching Text to the Reading Level of the Learner

To help students understand the meaning of terms and their use, it is important to provide clear, coherent, and short reading passages.

Science teachers can:

- select resources at various readability levels, e.g., newspapers and magazine articles, Internet;
- provide resources in which information is usually presented with minimal text;
- use informational text in which scientific terminology is defined where it is used, rather than in an end-of-book glossary.

Text Features and Structures

Students whose early reading concentrated on narrative fiction may not have been introduced to the patterns of text that are used in science (Strong et al., pp. 24-27). When students are familiar with the structures and can recognize them using clue words, they can use them to construct meaning. Graphic organizers capture these patterns visually. Text features, including parentheses, bold-faced and italic type, and headings with various font sizes can all be used as clues to meaning.

Science teachers can:

- teach students to preview a textbook (*Think Literacy*, pp. 8-10);
- teach students to analyse text features (*Think Literacy*, pp. 12-13);
- provide students with graphic organizers to collect notes from reading (Strong et al., pp. 4-14);
- have students find organization patterns in text using signal words (*Think Literacy*, pp. 16-19, 24-28).

Graphic Text

In Science, information can be meaningfully presented to students in visual images, charts, graphs, and maps.

Science teachers can help students interpret charts and graphs by:

- looking at the heading and predicting the axes or column headings;
- looking at the axes and headings and predicting what the graph will look like, or predicting whether the numbers will go up or down in a particular column or row.

Writing

Students write for many purposes in the Science classroom. They construct meaning and impart their findings from scientific research and investigations, e.g., using technology, charts, graphs, and templates.

In the workplace and in everyday life, students use similar forms of writing to convey information, e.g., instructions, graphic organizers, sequential lists.

Science teachers can help students:

- use charts, graphs, and other graphic organizers, e.g., Venn diagrams, flow charts, fish bone, or concept maps to display and organize scientific data and concepts (*Think Literacy*, pp. 108-109, *Beyond Monet*, pp. 280-283);
- construct logical and sequential procedures and instructions used in conducting scientific research and investigations (*Think Literacy*, pp. 142-143);
- learn how to structure scientific reports and explanations (*Think Literacy*, pp. 144-149, *Beyond Monet*, p. 252).

Appendix B: Sample Operator's Licence Tracking Form

Grade 10 Science

Licence Tracking Form

This certifies that

has completed the requirements to earn the licences identified below.

Licence	Date Earned	Inspector's Initials	Official Seal
Electrician Operator			
Handling Equipment (part 1)			
Handling Equipment (part 2)			
Microscope (part 1)			
Microscope (part 2)			
Microscope (part 3)			
Terminology: Biology			
Terminology: Chemistry			
Terminology: Physics			
WHMIS/HHPS			
Safety			

Appendix C: Rubric for Experimental Investigation

Category/Criteria	Level 1 (50-59%)	Level 2 (60-69%)	Level 3 (70-79%)	Level 4 (80-100%)
Inquiry • designs an experiment: - identify a problem - develop a question - follow a procedure to answer a question	- designs an experiment with limited effectiveness	- designs an experiment with moderate effectiveness	- designs an experiment with considerable effectiveness	- designs an experiment with a high degree of effectiveness
- selects and uses equipment and materials	- selects and uses equipment and materials safely and correctly only with supervision	- selects and uses equipment and materials safely and correctly with some supervision	- selects and uses equipment and materials safely and correctly	- demonstrates and promotes the safe and correct use of equipment and materials
- applies technical skills and procedures	- applies technical skills and procedures with limited competence	- applies technical skills and procedures with moderate competence	- applies technical skills and procedures with considerable competence	- applies technical skills and procedures with a high degree of competence
- gathers and records data	- gathers and records data with limited competence	- gathers and records data with moderate competence	- gathers and records data with considerable competence	- gathers and records data with a high degree of competence
- analyses and interprets data	- analyses and interprets data with limited competence	- analyses and interprets data with moderate competence	- analyses and interprets data with considerable competence	- analyses and interprets data correctly with a high degree of competence
Communication - uses scientific terminology, symbols, conventions, and standard units	- uses scientific terminology, symbols, conventions, and standard units with limited clarity and precision	- uses scientific terminology, symbols, conventions, and standard units with moderate clarity and precision	- uses scientific terminology, symbols, conventions, and standard units with considerable clarity and precision	- uses scientific terminology, symbols, conventions, and standard units with a high degree of clarity and precision
- organizes and communicates data gathered in graphic organizers	- organizes and communicates information with limited clarity	- organizes and communicates information with moderate clarity	- organizes and communicates information with considerable clarity	- organizes and communicates information with a high degree of clarity
Making Connections - understands the connections between experimental results and the behaviour of materials used in daily life	- shows limited understanding of connections	- shows some understanding of connections	- shows considerable understanding of connections	- shows a thorough understanding of connections

Note: A student whose achievement is below Level 1 (50%) has not met the expectations for this assignment or activity.

Coded Expectations, Locally Developed Compulsory Credit Course, Science, Grade 10, SNC2L

Scientific Inquiry: Science in Media

Overall Expectations

By the end of this course, students will:

SIMV.01 • explain how science-related information is presented in print and electronic media for different purposes and audiences;

SIMV.02 • investigate science-related information presented in print and electronic media using appropriate research and reporting skills;

SIMV.03 • evaluate claims and presentations of science-related information in media.

Specific Expectations

Understanding Basic Concepts

By the end of this course, students will:

SIM1.01 – identify the ways in which scientific information is conveyed (e.g., product labels; graphic text in billboards, newspapers, instructions; graphs and tables in magazines, TV, posters; visual images in print and electronic media; vocabulary and dialogue in radio advertising or movies);

SIM1.02 – discuss, using examples, how the method of presenting scientific information connects to the purpose (e.g., find and compare examples used for promotion, persuasion, education, entertainment);

SIM1.03 – explain how different formats used in the media to present science information target specific audiences (e.g., graphs and charts in health-related advertising, statistics on car performance, simplified vocabulary in movies, diagrams in newspapers).

Developing Skills of Inquiry and Communication

By the end of this course, students will:

SIM2.01 – formulate testable questions on science-related claims and conduct investigations based on the concept of a fair test (e.g., testing cleaning power of detergents or shampoos, lasting power of “waterproof” mascara, durability of skateboard wheels, water absorption by diapers);

SIM2.02 – research science-related information from a variety of electronic and other sources;

SIM2.03 – interpret research data, including analysis for accuracy and bias as appropriate, using a range of strategies for reading for information;

SIM2.04 – organize and communicate information collected from lab investigations and information research using graphic organizers.

Relating Science to Technology, Society, and the Environment

By the end of this course, students will:

SIM3.01 – formulate testable questions about science-related claims and representations in the media (e.g., advertising in print or on TV, information provided in a movie or TV show or website, science information used in magazine or newspaper stories);

SIM3.02 – develop procedures to assess these claims and representations, using information research and/or laboratory investigations;

SIM3.03 – evaluate the investigation and suggest improvements (e.g., present and defend their findings);

SIM3.04 – communicate science-related information to a workplace audience (e.g., hand-washing reminder, safe handling of cleaning chemicals, precautions for use of electrical devices) by creating a media work (e.g., webpage, poster, television commercial).

Chemistry: Interactions of Common Materials

Overall Expectations

By the end of this course, students will:

CIMV.01 • understand how chemicals in common household and workplace materials interact;

CIMV.02 • investigate the types and rates of interactions between commonly used materials through laboratory activities;

CIMV.03 • analyse how material interactions affect our daily lives.

Specific Expectations

Understanding Basic Concepts

By the end of this course, students will:

CIM1.01 – recognize the relationships among chemical formulae, composition, and common names (e.g., HCl(aq) , hydrochloric acid, muriatic acid);

CIM1.02 – classify chemicals into groups according to their behaviour (e.g., acids, bases, fuels, oxidizers), using appropriate scientific terminology;

CIM1.03 – distinguish between chemical reactions (e.g., burning paper, reacting metals with acids) and physical processes (e.g., crumpling paper, making and diluting solutions), using appropriate scientific terminology (e.g., reactants, products, change of state, concentration, solute, solvent);

CIM1.04 – identify the factors that alter the rate of physical processes and chemical reactions (e.g., temperature, surface area, concentration, presence of a catalyst/inhibitor).

Developing Skills of Inquiry and Communication

By the end of this course, students will:

CIM2.01 – select and use appropriate lab equipment and apply WHMIS safety procedures for the handling, storage, disposal, and recycling of laboratory materials;

CIM2.02 – conduct experiments to investigate how materials can interact chemically (e.g., combine steel wool with oxygen, neutralize an acid with a base, combine copper chloride and aluminum foil);

CIM2.03 – conduct experiments to investigate how materials can interact physically (e.g., calculate amounts needed for solutions, prepare and dilute solutions, prepare gels, foams, evaporate alcohol and water);

CIM2.04 – conduct experiments to determine the factors affecting rates of chemical reactions and physical processes (e.g., temperature, surface area, concentration, presence of a catalyst/inhibitor);

CIM2.05 – communicate the results of investigations using a variety of oral, written, and graphic formats.

Relating Science to Technology, Society, and the Environment

By the end of this course, students will:

CIM3.01 – research the interactions of materials that are used in daily life (e.g., hair or clothing dye, cleaning solvents, paints, fuels, silage, pesticides and herbicides, plastics);

CIM3.02 – analyse the costs and benefits of a specific material with reference to its interactions with other materials in the environment (e.g., solvents: flammability versus use in dry cleaning; plastics: light weight and can be formed into many different products versus hazardous when burned);

CIM3.03 – communicate an opinion, supported by evidence, about the use of a particular material, with consideration for both its physical and chemical interactions (e.g., plastic containers for food storage, latex paint for household exteriors, vinegar as cleaning agent, butane lighters, alternative materials for car body repair).

Biology: Living Together

Overall Expectations

By the end of this course, students will:

BLTV.01 • explain the strategies that organisms use for successful coexistence in populations and communities;

BLTV.02 • investigate, using appropriate laboratory and research skills, the implications of organisms existing in communities;

BLTV.03 • analyse the challenges that arise from organisms living in communities.

Specific Expectations

Understanding Basic Concepts

By the end of this course, students will:

BLT1.01 – summarize the potential benefits of organisms living together in communities (e.g., protection, shared food supply, sharing of resources, improved hunting success and nurturing of young);

BLT1.02 – identify challenges that arise from organisms living together in communities, including human populations (e.g., maintaining the balance of nature, competition between individuals for limited resources, pollution due to waste production, spreading of disease);

BLT1.03 – compare the strategies used by various communities of organisms to successfully coexist (e.g., social organization of insects or animals that may include division of labour, communication, and co-operation; plantation tree growth in limited space);

BLT1.04 – use appropriate scientific terminology related to concepts of organisms living together (e.g., species, population, community, colony, biodiversity).

Developing Skills of Inquiry and Communication

By the end of this course, students will:

BLT2.01 – plan and conduct an experiment to investigate the results of overcrowding in microscopic populations (e.g., growing yeast populations, non-pathogenic bacteria cultures), including estimation and measurement of population size;

BLT2.02 – plan and conduct an experiment to investigate the results of overcrowding in macroscopic populations (e.g., growing plants in close proximity, fruit fly culture) including measuring rate of growth of population size;

BLT2.03 – make accurate observations of the organisms that exist in a community (e.g., pond water), using a microscope;

BLT2.04 – make observations, directly or using technologies, to determine the benefits and challenges of living in communities (e.g., observe social structure in an ant colony, examine fruit fly populations, whale pods, wolf packs, meerkat communities, human populations);

BLT2.05 – use a variety of research strategies to determine the roles of specific organisms within a community (e.g., different roles found in bee communities, in lion prides, schools of fish, migrating birds);

BLT2.06 – explain and interpret observations by summarizing patterns obtained from graphing data, organizing information, and communicating orally and in writing.

Relating Science to Technology, Society, and the Environment

By the end of this course, students will:

BLT3.01 – develop a simple action plan, using a consistent written format, to address an environmental concern (e.g., to conduct school recycling program that addresses waste management; to promote car-pooling or public transit to reduce air pollution; to practise conservation during fishing and hunting to maintain animal populations; to operate a composter successfully; to manage a school garden to maintain plant populations; to participate in community or national data collection projects such as bird, insect, or tree population surveys);

BLT3.02 – determine, through a case study, and explain how humans organize their communities to address challenges of living together (e.g., waste management in a workplace, regulations on water treatment, disease control, smoking, responsibilities within a school or community for conservation of resources, operation of a local food bank, by-laws on the use of herbicides).

Physics: Using Electrical Energy

Overall Expectations

By the end of this course, students will:

PEEV.01 • explain the generation, measurement, and conversion of electricity;

PEEV.02 • investigate the factors that affect the generation and use of electricity;

PEEV.03 • analyse the social, economic, and/or environmental implications of the sources and uses of electrical energy.

Specific Expectations

Understanding Basic Concepts

By the end of this course, students will:

PEE1.01 – describe different methods of generating electricity from other forms of energy (e.g., batteries, hydro, solar);

PEE1.02 – define and describe electrical concepts (e.g., amps, volts, current, potential difference, energy and power) and their units (e.g., kWh, joules, watts);

PEE1.03 – determine quantitatively and/or qualitatively the energy and power associated with electrical devices (calculate energy use using time and power rating on appliance, measure output of voltaic cell);

PEE1.04 – identify the range of uses for electrical energy in our society and the energy conversions involved (e.g., heating, labour-saving devices in the home and workplace, transportation, lighting, entertainment, communications).

Developing Skills of Inquiry and Communication

By the end of this course, students will:

PEE2.01 – locate and select information from various sources (e.g., print, electronic, community resources and personally collected information) to identify factors affecting generation and use of electricity;

PEE2.02 – design and build an electrical device (e.g., a voltaic cell, a coil of wire and a moving magnet; a windmill/waterwheel connected to a generator), using lab equipment and materials safely;

PEE2.03 – modify the electrical device they built to increase the amount of electrical energy it produces;

PEE2.04 – determine and record the electrical energy and power of electrical device;

PEE2.05 – communicate information using appropriate formats for specific purposes and audiences (e.g., orally explain the electrical device, use a table or chart for measurement, create a diagram for design).

Relating Science to Technology, Society, and the Environment

By the end of the course, students will:

PEE3.01 – compare technologies used for generating electrical energy, including their social, economic, or environmental implications (e.g., advantages and disadvantages of batteries, hydro, solar, coal, wind, nuclear);

PEE3.02 – design and implement a plan to reduce electrical consumption at home, at school, or in a workplace, based on identified consumption patterns.

Ontario Catholic School Graduate Expectations

The graduate is expected to be:

A Discerning Believer Formed in the Catholic Faith Community who

- CGE1a** -illustrates a basic understanding of the **saving story** of our Christian faith;
- CGE1b** -participates in the **sacramental life** of the church and demonstrates an understanding of the centrality of the Eucharist to our Catholic story;
- CGE1c** -actively reflects on **God's Word** as communicated through the Hebrew and Christian scriptures;
- CGE1d** -develops attitudes and values founded on Catholic **social teaching** and acts to promote social responsibility, human solidarity and the common good;
- CGE1e** -speaks the **language of life...** "recognizing that life is an unearned gift and that a person entrusted with life does not own it but that one is called to protect and cherish it." (Witnesses to Faith)
- CGE1f** -seeks intimacy with God and celebrates **communion** with God, others and creation through prayer and worship;
- CGE1g** -understands that one's purpose or **call in life** comes from God and strives to discern and live out this call throughout life's journey;
- CGE1h** -respects the **faith traditions**, world religions and the life-journeys **of all people of good will**;
- CGE1i** -integrates faith with life;
- CGE1j** -recognizes that "sin, human weakness, conflict and forgiveness are part of the human journey" and that the cross, the ultimate sign of forgiveness is at the heart of **redemption**. (Witnesses to Faith)

An Effective Communicator who

- CGE2a** -listens actively and critically to understand and learn in light of gospel values;
- CGE2b** -reads, understands and uses written materials effectively;
- CGE2c** -presents information and ideas clearly and honestly and with sensitivity to others;
- CGE2d** -writes and speaks fluently one or both of Canada's official languages;
- CGE2e** -uses and integrates the Catholic faith tradition, in the critical analysis of the arts, media, technology and information systems to enhance the quality of life.

A Reflective and Creative Thinker who

- CGE3a** -recognizes there is more grace in our world than sin and that hope is essential in facing all challenges;
- CGE3b** -creates, adapts, evaluates new ideas in light of the common good;
- CGE3c** -thinks reflectively and creatively to evaluate situations and solve problems;
- CGE3d** -makes decisions in light of gospel values with an informed moral conscience;
- CGE3e** -adopts a holistic approach to life by integrating learning from various subject areas and experience;
- CGE3f** -examines, evaluates and applies knowledge of interdependent systems (physical, political, ethical, socio-economic and ecological) for the development of a just and compassionate society.

A Self-Directed, Responsible, Life Long Learner who

- CGE4a** -demonstrates a confident and positive sense of self and respect for the dignity and welfare of others;
- CGE4b** -demonstrates flexibility and adaptability;
- CGE4c** -takes initiative and demonstrates Christian leadership;
- CGE4d** -responds to, manages and constructively influences change in a discerning manner;
- CGE4e** -sets appropriate goals and priorities in school, work and personal life;
- CGE4f** -applies effective communication, decision-making, problem-solving, time and resource management skills;
- CGE4g** -examines and reflects on one's personal values, abilities and aspirations influencing life's choices and opportunities;
- CGE4h** -participates in leisure and fitness activities for a balanced and healthy lifestyle.

A Collaborative Contributor who

- CGE5a** -works effectively as an interdependent team member;
- CGE5b** -thinks critically about the meaning and purpose of work;
- CGE5c** -develops one's God-given potential and makes a meaningful contribution to society;
- CGE5d** -finds meaning, dignity, fulfillment and vocation in work which contributes to the common good;
- CGE5e** -respects the rights, responsibilities and contributions of self and others;
- CGE5f** -exercises Christian leadership in the achievement of individual and group goals;
- CGE5g** -achieves excellence, originality, and integrity in one's own work and supports these qualities in the work of others;
- CGE5h** -applies skills for employability, self-employment and entrepreneurship relative to Christian vocation.

A Caring Family Member who

- CGE6a** -relates to family members in a loving, compassionate and respectful manner;
- CGE6b** -recognizes human intimacy and sexuality as God given gifts, to be used as the creator intended;
- CGE6c** -values and honours the important role of the family in society;
- CGE6d** -values and nurtures opportunities for family prayer;
- CGE6e** -ministers to the family, school, parish, and wider community through service.

A Responsible Citizen who

- CGE7a** -acts morally and legally as a person formed in Catholic traditions;
- CGE7b** -accepts accountability for one's own actions;
- CGE7c** -seeks and grants forgiveness;
- CGE7d** -promotes the sacredness of life;
- CGE7e** -witnesses Catholic social teaching by promoting equality, democracy, and solidarity for a just, peaceful and compassionate society;
- CGE7f** -respects and affirms the diversity and interdependence of the world's peoples and cultures;
- CGE7g** -respects and understands the history, cultural heritage and pluralism of today's contemporary society;
- CGE7h** -exercises the rights and responsibilities of Canadian citizenship;
- CGE7i** -respects the environment and uses resources wisely;
- CGE7j** -contributes to the common good.

Unit 1: Scientific Inquiry: Science in Media

Time: 12 hours

Unit Description

Scientific literacy is critical for students in an increasingly technological and scientific world. Students are bombarded with science-based claims and a solid base of scientific inquiry skills enables them to distinguish between fact and opinion and to understand media bias in order to make informed decisions. Students are exposed to a variety of opinions and messages.

The scientific inquiry and critical thinking skills developed in this unit are revisited throughout the course and ensure students prepare for success in the final unit evaluation. Media and scientific literacy are emphasized throughout the unit, enabling students to question the presentation of science information in the media.

Students focus on reviewing the laboratory and investigation skills required to evaluate science-based claims through experimental research. Students examine various modes of science-related media and learn to analyse media for the messages portrayed and then investigate a science-related issue through media-based research. Throughout the unit, they practise the Essential Skills of reading text, document use, numeracy, oral communication, computer use, decision making, and working with others.

Unit Synopsis Chart

Activity/Time	Learning Expectations	Assessment and Evaluation Categories, Tasks, and Tools	Tasks
1.1 Investigating Media Claims Experimentally 4 hours	SIMV.02, .03, SIM2.01, 2.04, 3.01, 3.02 CIMV.02, CIM2.01 CGE5a	1.1.1: Student performance is diagnostically assessed for Inquiry and Communication, using a checklist. 1.1.2: Student performance, oral responses, and written reports are assessed for Inquiry and Communication, using a checklist. Students self-assess social and group skills. Students' strengths and deficits in literacy, numeracy, and social skills are diagnostically assessed.	Students: <ul style="list-style-type: none">• complete questionnaires and prepare graphs;• participate in group activities;• review safety rules;• review lab equipment and safe handling;• conduct short experiments and analyse results;• analyse science claims in the media experimentally.

Activity/Time	Learning Expectations	Assessment and Evaluation Categories, Tasks, and Tools	Tasks
1.2 Understanding Media 4 hours	SIMV.01, .03, SIM1.01, 1.02, 1.03, 3.04 CGE2b, 2c, 3b	1.2.1: Bar graph is assessed for numeracy skills. 1.2.2: Pie chart is peer and self-assessed for data presentation. 1.2.3: 'Needs' and 'wants' are used for diagnostic assessment of student's maturity and understanding of community. 1.2.4: Deconstruction of the media ad is assessed for Knowledge/Understanding and Inquiry, using a checklist and returned for immediate feedback. 1.2.5: Modified ad and answers to deconstruction questions are evaluated for Knowledge/Understanding, Inquiry, and Making Connections, using a rubric.	Students: <ul style="list-style-type: none"> • evaluate personal wants and needs; • represent data using graphs; • evaluate wants and needs from different perspectives; • analyse science-related media ads for target audience, purpose, and appeal; • deconstruct ads for audience and purpose; • prepare an advertisement for a community stakeholder.
1.3 Investigating Science Issues using Media-Based Research 4 hours	SIMV.02, .03, SIM2.02, 2.03, 2.04, 3.02 CGE2e, 3f, 4f	1.3.1: Student understanding of fact, opinion, and bias is formatively assessed. 1.3.2: Student technology skills are diagnosed for future consideration. 1.3.3: Evaluation checklist is assessed for Inquiry and Making Connections, using a checklist. The graphic organizer is assessed for Inquiry and Making Connections, using a checklist. 1.3.5: Completed Making Judgements Master Form is assessed for Making Connections, using a checklist.	Students: <ul style="list-style-type: none"> • analyse media for fact, opinion, and bias; • evaluate websites for bias, reliability, and content; • gather information from various media; • investigate one side of a science-related issue in the role of stakeholder; • investigate the other side of an issue as reporter; • make a decision based on media information gathered from both sides of an issue.

Activity 1.1: Investigating Media Claims Experimentally

Time: 4 hours

Description

Students are introduced to each other through group teambuilding activities. During these activities, students review the scientific inquiry process, which includes asking questions, planning, and conducting experiments, to test scientific claims commonly seen on labels and in advertisements. Teachers assess students' literacy, mathematical literacy, scientific inquiry, and social skills. Essential Skills addressed include reading text, document use, problem solving and working with others.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE5a - works effectively as an interdependent team member.

Strand(s): Scientific Inquiry: Science in Media; Chemistry: Interactions of Common Materials

Overall Expectations

SIMV.02 - investigate science-related information presented in print and electronic media, using appropriate research and reporting skills;

SIMV.03 - evaluate claims and presentations of science-related information in media;

CIMV.02 - investigate the types and rates of interactions between commonly used materials through laboratory activities.

Specific Expectations

SIM2.01 - formulate testable questions and carry out investigations on science-related claims based on the concept of a fair test;

SIM2.04 - organize and communicate information collected from lab investigations and information research using graphic organizers;

SIM3.01 - formulate testable questions about science-related claims and representations in the media;

SIM3.02 - develop procedures to investigate these claims and representations, using information research and/or laboratory investigations;

CIM2.01 - select and use appropriate lab equipment and apply WHMIS safety procedures for the handling, storage, disposal, and recycling of laboratory materials.

Prior Knowledge & Skills

- Exposure to WHMIS and HHP symbols
- Experience in safe use of equipment and general lab procedures
- Exposure to experimental inquiry process

Planning Notes

- Students who obtained WHMIS/HHP Safety and Handling Lab Equipment Part 1 licences in Grade 9 could recertify. The WHMIS test, allowing students to earn a certificate, is available online through the Safety Passport.
- It would be beneficial for science teachers to work with Careers, English, and Math teachers as a team. All of these courses could support each other in creating a rich learning environment for these students.
- Prior consultation with Grade 9 teachers, the Guidance Department, and/or Special Education Resource teachers will be helpful.
- Where possible, use authentic workplace documents.
- The format, sections, and methods of storing the student portfolio should be decided. It is suggested that in addition to tracking academic achievement, students also keep a learning skills tracking sheet in their portfolio to track their own successes in individual and group work. Information on learning preferences and styles, student reflections, and all licences form part of the portfolio.
- At the beginning of each period, the teacher introduces a social skill, asks students what it looks like, and models this skill. At the end of the class, students can keep track of the skill and reflect on their achievement. These can be prepared in advance.
- Students may need an oral safety test and scribing. If students require text-to-speech or speech-to-text, i.e., Kurzweill, adaptive technologies, ensure that the reading materials have been scanned and that the technology is available for student use.

1.1.1 Assigning Groups and Teamwork

- Decide how to assign groups, ensuring that students have an opportunity to meet other students.
- Prepare one chart for each group for comparing likes and dislikes.

- Prepare the styrofoam cups and a super-absorbent substance for the group activity if the suggested activity (see article “Tricky Science” in Resources) is to be used. This (Super Gel[®] or sodium polyacrylate) substance can be purchased or obtained from diapers. Measure the amount of water (mass or volume) that can be absorbed by a specified amount of your absorbent. Make this the ‘claim’ for the group activity. Alternatively, plan the discrepant event and related claim for students to investigate. It should be completed in one-half hour and require no safety training, e.g., which paper towel is stronger when wet, which paper towel absorbs the most moisture.
- Prepare bulletin board for posting claims from the media brought in by students.

1.1.2 Inquiry Skills: Adbusters

- Check Department, school, and School Board policies on safety in the science lab, or consult the STAO Stay Safe document for a list of safety rules. These may require the students’ signatures. Prepare copies for each student together with lists of safety hazard symbols. For WHMIS, use the WHMIS Brochure Authentic Document from the Essential Skills website (see Resources). Post the lab rules in the class.
- Prepare the Safety Game Boards and Safety Review Cards. These can be laminated for future use. Prepare several safety quizzes that can be marked immediately, i.e., multiple choice.
- Set up the Adbusters activity stations (Appendix 1.1.3: Suggested Diagnostic Activities for Adbusters). Consider the class layout so that adequate attention can be given to the observation of student performance during the lab activities. Prepare instruction sheet for each activity.
- Prepare bulletin boards for collecting ad claims and classifying as testable by experiment or not testable.
- Post pictures of equipment with names for student use.
- Prepare the student booklets for recording. (Booklet includes question asking whether it was a ‘fair test’ and what should be done to change it if it was not.)
- Collect ads and prepare scientific claims for student analysis. Some should be testable by experiment, some not.

Teaching/Learning Strategies

1.1.1 Assigning Groups and Teamwork

- Students complete a questionnaire on likes and dislikes (reading material, card or board games, food, music, sports, school subjects, TV programs, radio stations, etc.), hobbies, difficult courses, previous experience in science, realistic time available for homework, etc. The teacher models answers with the students (emphasizing that this information will be shared with others) and diagnostically assesses any immediate academic difficulties.
- Students are assigned to a group of three or four students. The teacher explains the importance of teamwork in science and the workplace together with the day’s social skill. Students introduce themselves, compare their strengths. From this, students create a name for their group.
- Students are introduced to the portfolio.
- The teacher assists students to develop some norms for group and class operations, e.g., assignment of roles, positive interdependence, personal responsibility.
- Students observe a discrepant event (see Resources) that can be related to a scientific claim. They plan an investigation to test the validity of the claim. During the activity, the teacher observes social skills and problem-solving strengths and deficits.
- Groups share results and participate in teacher-directed class discussion dealing with the concept of ‘fair test.’ They are encouraged to search the media (print, TV, movies, and radio) and bring in claims to add to the bulletin board.
- Students complete a group reflection on the activity.

1.1.2 Inquiry Skills: Adbusters

- Students participate in a teacher-led discussion to review the concept of fair test.
- Students review the scientific inquiry process as a series of four Inquiry/Research Steps:
 - Stage 1: Preparing for Research (Deciding on a Problem, Questioning, and Hypothesizing);
 - Stage 2: Accessing Resources (Designing and Conducting an Experiment);
 - Stage 3: Analysing Results and Forming Conclusions;
 - Stage 4: Transferring Knowledge (Presenting Information, Applying Results in Everyday Life).These can be compared to problem solving in math and will be used to compare with media-based investigations later.
- In pairs, students generate criteria for the practicality of investigating claims by conducting experiments. Ads and media claims are classified as experimentally testable or not. The teacher gathers the criteria from class discussion.
- Students are introduced to the short tasks they will accomplish in groups. They take the role of Adbusters, using their scientific skills to prove or debunk claims, while demonstrating their understanding of inquiry strategies and skills. Students review the names and use of equipment they will be using. The teacher reviews safe use of beaker tongs, thermometer, and balance. These are listed in the portfolio under the headings: Equipment Name, Equipment Picture, Use, and Special Precautions.
- In the same groups used for the previous activity, all students review basic lab safety rules and hazard symbols using the Safety Game Board and Safety Review Cards (see Appendix 1.1.1: Safety Review Game Suggested Activity). The teacher circulates to identify students who appear to be familiar with the rules and students who may have difficulty with reading.
- Students write a short safety quiz before moving to the Adbuster activities. The group works together to assist all members to pass the quiz. Several quizzes may be available for students to try.
- Students participate in five short activities as Adbusters in groups or pairs. Each activity is framed around investigating a fictional claim (see Appendix 1.1.2: Suggested Diagnostic Activities for Adbusters). Students keep recorded information individually in a booklet. While students participate in the activities, the teacher observes students' inquiry skills and tracks those completing the Operators Licence – Handling Lab Equipment Part 1.
- Students hand in completed booklets and review the inquiry process with the teacher by examining the rubric they will use throughout the course. This rubric is placed in their portfolios for use in later units (Appendix C: Rubric for Experimental Investigation).
- Students complete a group and individual reflection on performance for the portfolio.

Assessment & Evaluation of Student Achievement

See Assessment & Evaluation of Student Achievement in Overview, p. 8.

- In activity 1.1.1, student performance is diagnostically assessed for Inquiry and Communication using a checklist.
- In activity 1.1.2, student performance, oral responses, and written reports are assessed for Inquiry and Communication using a checklist.
- Students self-assess group and social skills using reflections. In addition, student performances are diagnostically assessed for strengths and weaknesses in literacy, numeracy, and social skills.

Resources

Science Resources

Print

Grace, Eric. *SCIENCEPOWER 10™*. Toronto: McGraw-Hill Ryerson Limited, 2000. ISBN 0075603632

Ritter, Robert, Donald Plumb, Frank Jenkins, Hans van Kessel, and Alan Hirsch. *Nelson Science 10*. Toronto: Nelson Thomson Learning, 2000. ISBN 0176075011

Science Teachers of Ontario. *Stay Safe*. Toronto: STAO, 2002. ISBN 1-894592-22-0

Teaching and Learning Resources

Print

Bennett, B., and C. Rolheiser. *Beyond Monet*. Toronto: Bookstation, 2001. ISBN 0969538839

Bennett, B., C. Rolheiser, and L. Stevahn. *Cooperative Learning: Where Heart Meets Mind*. Toronto: Educational Connections, 1991. ISBN 0969538804

Clarke, J., R. Wideman, and S. Eadie. *Together We Learn*. Scarborough: Prentice Hall, 1990. ISBN 0139245561

Ontario School Library Association. *Information Studies: Kindergarten to Grade 12: Curriculum for Schools and School Library Information Centres*. Toronto: OLA, 1999.

Rolheiser, C., B. Bower, and L. Stevahn. *The Portfolio Organizer: Succeeding with Portfolios in Your Classroom*. Alexandria, VA: ASCD, 2000. ISBN 087120374X

Silver, H., R. W. Strong, and M. J. Perini. *So Each May Learn: Integrating Learning Styles and Multiple Intelligences*. Alexandria, VA: ASCD, 2000. ISBN 0871203871

Stewart, Mike. "Tricky Science." *Science Scope*, 28: 1 (September 2004)

Tomlinson, Carol Ann. *How to Differentiate Instruction in Mixed-Ability Classrooms*. Alexandria, VA: ASCD, 1995. ISBN 087120245X

Websites

Ontario School Library Association – www.accessola.com

Assessment and Evaluation Resources

Print

Bellanca, J., C. Chapman, and E. Swartz. *Multiple Assessments for Multiple Intelligences*. Arlington Heights, Illinois: Skylight Training and Publishing Inc., 1997. ISBN 1-57517-076-0

Gregory, K., C. Cameron, and A. Davies. *Self-Assessment and Goal Setting*, 2000. (ISBN 0968216021); *Conferencing and Reporting*, 2001 (ISBN 096821603X); *Setting and Using Criteria*, 1997 (ISBN 0968216013). Merville, B.C: Connections Publishing

Workplace Link Resources

Websites

Essential Skills – www.15.hrdc-drhc.gc.ca

Live Safe Work Smart – www.livesafeworksmart.net

Appendix 1.1.1: Safety Review Game Suggested Activity

A simple game board is prepared with squares of four different colours. These can be laminated for constant use. Students use a spinner or number cubes. When they land on one colour, another student pulls a colour-coded card from the deck supplied, and the student who is in play must answer the question correctly or go back to the last space. The card has an acceptable answer on the reverse side. The game board can be used for other types of review. In this case, the cards have questions based on lab scenarios or WHMIS/HHP. Four safety topics are considered: Personal Protective Equipment, Accidents and Spills, Safe Disposal, and Lab Behaviour.

Appendix 1.1.2: Suggested Diagnostic Activities for Adbusters

Activity	Claim	Equipment Required	Instructions	Diagnostic
1	Our Styrofoam cups keep your coffee hotter than your own mug.	<ul style="list-style-type: none">• Kettle• Water• Graduated beaker• Beaker tongs• Two thermometers• Mug• Styrofoam cup• Support for mug and cup• Stopwatch	<ol style="list-style-type: none">1. Pour different volumes of hot water into mug and styrofoam cup following safety procedures.2. Measure the temperature immediately and after 5-10 minutes.	<ul style="list-style-type: none">• following instructions• measuring temperature and volume• using beaker tongs correctly• using thermometer correctly• recording data• analysing experimental procedure for fair test flaws
2	Our value vitamin pack contains 25% more product than our nearest competitor's product.	<ul style="list-style-type: none">• Two containers with 'product' (use small candies and make the claim incorrect)• Watch glasses or small dry beakers• Graduated cylinder• Balance	<ol style="list-style-type: none">1. Outline at least two ways to check the claim.2. Record supporting data	<ul style="list-style-type: none">• designing experiment• understanding concepts of volume and mass• measuring volume or mass• understanding concept of percentage• recording data
3	Our package's dimensions are only two times the size of our nearest competitor's product, but our package holds eight times as much product.	<ul style="list-style-type: none">• Rulers• Balance• Two boxes filled with the same material but with the length, widths, and heights twice the size (paper constructions will work for this – use simple measurements)	<ol style="list-style-type: none">1. Measure the lengths, widths, heights, and masses of the packages.2. Record the data.3. Test the claim by referring to the data.4. Calculate the volumes, compare volumes to masses, and make any possible connections.	<ul style="list-style-type: none">• using the balance• using a ruler for linear measure• understanding how to calculate volume• understanding ratios• understanding concept of volume

Appendix 1.1.2: Suggested Diagnostic Activities for Adbusters (continued)

Activity	Claim	Equipment Required	Instructions	Diagnostic
4	The sales of our brand are increasing in every sector.	<ul style="list-style-type: none">• Table with sales data over 6 months for children, teenagers, adults, and seniors, and with a total at the bottom.• Graph paper	<ol style="list-style-type: none">1. Examine the table and decide whether the claim is true or not.2. Graph one of the four sectors and the total sales over the four months.	<ul style="list-style-type: none">• interpreting data• reading tables• preparing graphs
5	Designing the experiment	<ul style="list-style-type: none">• A group of 4 or 5 claims, some of which cannot be investigated by experiment. Those that can should be testable with simple equipment.	<ol style="list-style-type: none">1. Choose a claim that can be investigated by experiment.2. Write a procedure to prove one of the claims.3. List the materials required.	<ul style="list-style-type: none">• planning experiment• concept of fair test• writing procedure• understanding which claims can be investigated experimentally

Activity 1.2: Understanding Media

Time: 4 hours

Description

Students are introduced to various science-related concepts linked with marketing in the media, to enable them to become more media-aware consumers. They analyse the concepts of ‘needs’ and ‘wants,’ understand that different stakeholders in society perceive wants and needs differently and deconstruct various forms of media for purpose, audience, and bias. In order to appreciate how media often markets a ‘want’ as a ‘need,’ students analyse community profiles to make decisions about the potential audience that can be targeted by the media. They then modify an existing science-related advertisement to suit the target audience. These activities provide students with concrete resources for their portfolio, which they may use as support for their media campaign in Unit 5 and media works produced throughout the course.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE2b - reads, understands, and uses written materials effectively;

CGE2c - presents information and ideas clearly and honestly with sensitivity to others;

CGE3b - creates, adapts, and evaluates new ideas in light of the common good.

Strand(s): Scientific Inquiry: Science in Media

Overall Expectations

SIMV.01 - explain how science-related information is presented in print and electronic media for different purposes and audiences;

SIMV.03 - evaluate claims and presentations of science-related information in media.

Specific Expectations

SIM1.01 - identify and compare the ways in which scientific information is conveyed effectively;

SIM1.02 - discuss, using examples, how the method of presenting information connects to the purpose;

SIM1.03 - explain how different formats used in the media to present science target specific audiences;

SIM3.04 - communicate science-related information to a workplace audience by creating a media work.

Prior Knowledge & Skills

- Ability to work positively in groups
- Ability to use literacy skills, e.g., reading for information, graphical text, reading for inference

Planning Notes

- Meet with teachers of English and Mathematics to integrate student support. This Activity is tightly linked to students’ literacy and numeracy skills.

1.2.1 Our Needs and Wants

- Prepare user-friendly bulleted lists and checklists for creating scientific graphs (bar graphs and pie charts) and tables. These should be included by students in their portfolio.
- Assemble a word or picture flash card list or a bin with pictures of different materials classified as ‘wants’ or ‘needs’ that can be, e.g., hairdryer, backpacks, anti-bacterial soap, cars, computer, chauffeur, cosmetics, designer clothes, stationery, credit card. Include information that may influence consumers such as price, brand name, where it was bought, etc. Note: In preparation for Activity 5, the list should include electrical appliances.

1.2.2 Representing Data

- Prepare a user-friendly list of common ratios, e.g., fractions and percentages, and the pie charts they represent, e.g., one-half, one-third, one-fifth, or obtain these from mathematics department. They may be given out to students as photocopies, as a resource in their portfolios.
- Prepare notes or templates for directed note-taking, e.g., fill-in-the-blanks, questions with space to answer or draw pictures, graphic organizers, on: how to convert fractions to percentages and represent them on pie charts, and how ‘wants’ and ‘needs’ may sometimes be different for different people.

1.2.3 Needs and Wants from Different Perspectives

- Prepare blank Venn diagram templates, with space below the diagram to answer questions.
- Provide a copy of Maslow’s hierarchy, with space for explanations.
- Create simple profiles of community members – for example, cards that have one sentence, e.g., someone who lives within walking distance of work, a family with a dog, a teacher who has a child in primary school. Prepare the profiles with sensitivity, taking into account that students in the classroom may or may not have exposure to different communities around them. A fictional community may be used in place of the school community.

1.2.4 Deconstructing Media

- Prepare detailed profiles of different stakeholders in the community, e.g., single parent, retired person, working parent with or without children, including but not limited to: age, income, family characteristics, education, job description, social activities they participate in, description of a typical day, what they drive, etc. Prepare the profiles with sensitivity, taking into account that students in the classroom may or may not have exposure to the different communities around them. However, select profiles that broaden student outlook and insight into other types of families/communities/lifestyles.
- Create guiding questions for students to extract information from a profile.

1.2.5 Community Market

- Gather a variety of science-related media presentations for students to deconstruct, e.g., a poster, a petition, part of a campaign or a full campaign, a brochure, video, or rap song. **Note:** In preparation for activity 1.2.5, themes should include environmentally related topics such as acid precipitation, oil spills, global warming, health effects of particulate matter, sustainable forms of energy, and non-sustainable forms of energy, e.g., fossil fuels.
- Prepare a checklist of guiding questions to be used in deconstruction. Deconstruction questions focus on concepts such as personal concerns, appealing to different audiences, lifestyles, bias, and presentation style.

Teaching/Learning Strategies

1.2.1 Our Needs and Wants

- The teacher distributes accepted conventions for scientific graphs and tables, including bar graphs, pie charts and tables. These are placed in portfolio for future reference.
- Students are given a word/picture flash-card list of different materials, including information such as price, brand name, where it was bought, and any other factors that may influence the consumer’s decision to buy. The list should include electrical appliances, in preparation for activity 1.2.5.
- Students rate each material on how badly they want it, on a scale of 0 – 5. They draw a bar graph of rating scale against materials. The order in which the materials are graphed is not important, but should be the same for all students and specified before the graph is drawn. All bars that are +5 are shaded to identify what they perceive as a need. During this process, the teacher reviews rules for drawing bar graphs.

- In small groups, they visually compare their bar graphs to their peers by answering questions:
 - a) Are the shaded bars the same for me and my peer,? e.g., Did we perceive the same materials as needs?
 - b) Are the bars for each material the same as my peers?, i.e., Did we both put +4 for a hairdryer?
These answers may be written below the bar graph.
- Through a class discussion, students are led to understand that some needs and wants are perceived differently by different individuals, based on their individual experiences, e.g., a musician may want to buy a guitar more than a non-musician would.
- Students submit graphs for assessment and then place them in their portfolio.

1.2.2 Representing Data

- A class tally of how many students perceive each material as a want or a need is recorded in a table that follows proper scientific conventions, e.g., labelled with the headings Material, Number of Students Who Need, Number of Students Who Want, Total Students, on the board. Students copy the information from the board and place it in the portfolio as an exemplar.
- The teacher models conversion of simple fractions to percentages and how a percentage can be represented on a pie chart through estimation. Prepared pie charts for common ratios (both percentages and fractions) are provided and placed in the portfolio as reference, e.g., one-half as 50%, one-third as 33%, one-tenth as 10%.
- Students choose some of the data represented on the table to calculate the percentage of students who perceive something as a need or a want. They draw an approximate representation of this ratio in a properly labelled pie chart, e.g., 35% can be rounded to approximately 33. 3% or one-third of the pie chart. After this process, students edit their charts using a pie-chart checklist, submit rough work and pie chart(s) for assessment, and add them to the portfolio.

1.2.3 Needs and Wants from Different Perspectives

- Students are given flashcards of a short list of materials, e.g., computer, cosmetics, designer clothes, stationery, credit card, and are asked to classify them as needs or wants from their own and another's perspective, e.g., a pop star, a student in primary school. This is represented in a Venn diagram, with the area of overlap being materials that are perceived as needs and wants by both.
- In small group discussions, students answer the following questions below the diagram:
 - a) Which material was perceived by both groups as a need or a want?
 - b) Which material is only perceived by one group as a need or want?
 - c) What about their lifestyle or values makes this a need or a want, e.g., both a pop star and a student need clothes, but a pop star may need designer clothes because they get paid to sell different brands.
- The teacher guides students through a prepared list of wants and needs, including food, water, shelter, clothing, and Maslow's hierarchy (sense of safety, avoidance of pain) and uses this to conduct a lesson on a definition of need and want and how these can change. Students are also introduced to the idea that media sells based on these needs and it also tries to make wants into needs. Students may take notes through directed writing and place these into their portfolios for future reference.
- Using a simple profile of two members of a community, e.g., someone who lives within walking distance of work, a family with a dog, a teacher who has a child in primary school, students submit for evaluation a short list of their potential needs and wants as a Venn diagram. **Note:** This activity should introduce and/or link students in a meaningful, sensitive, and non-threatening manner to the diversity of the local community. Similarly, it should introduce students to basic socio-economic concepts, e.g., spending power and income/family structure. This activity may function as a diagnostic tool for activity 1.2.4 by gauging students' understanding of how different groups define wants and needs differently.

1.2.4 Deconstructing Media

- Students look at a variety of ads with science-related information, e.g., a poster, petition, brochure, video, rap song, and select one ad to deconstruct as a group.
- The teacher models deconstructing media for key elements by answering some science-related questions to determine fact versus fiction. Students use these questions as a guideline to deconstruct their own ad and present this information, e.g., in a paragraph.
- The teacher models deconstructing media for more subtle individual factors by answering some questions. Students use these questions as a guideline to deconstruct their own science-related media ad and present this information, e.g., in an oral presentation.

1.2.5 Community Market

- Students are introduced to the idea of stakeholders in a community. As a class, they make a list of potential stakeholders in their community, look at prepared community profiles of different stakeholders, and select the five most appropriate for them. These profiles of community stakeholders are placed in their portfolio.
- The teacher models reading community profiles and extracting relevant information from these profiles, e.g., age, income, family characteristics and education. Using a Master Form (workplace term for a template) as guiding questions, students read these profiles and extract this information. The completed Master Forms are placed in their portfolio. The teacher continues to assess literacy skills during the activity.
- Students are introduced to the rubric used to evaluate this activity.
- Students analyse a marketing ad, e.g., for sports equipment, automobile, trip overseas, health or safety campaign, and deconstruct it, using the resources in their portfolio, to answer basic questions such as: Who created this message? What techniques are used to attract my attention? What lifestyles, values, and points of view are represented in or omitted from this message? Why was this message sent? Which stakeholder does this ad appeal to? How might a different stakeholder (from the community profiles) understand this message differently?
- Students use the information from their deconstruction to modify the ad to appeal to a different stakeholder in their community. The modified ad and the answers to the deconstruction questions are submitted for evaluation with a rubric.

Assessment & Evaluation of Student Achievement

See Assessment & Evaluation of Student Achievement in Overview, p. 8.

- In activity 1.2.1, the bar graph is assessed for numeracy skills.
- In activity 1.2.2, the pie chart is peer and self-assessed for data presentation.
- In activity 1.2.3, needs and wants are used for diagnostic assessment of student's maturity and understanding of community
- In activity 1.2.4, the deconstruction of the media ad is assessed for Knowledge/Understanding and Inquiry using a checklist and is returned for immediate feedback.
- In activity 1.2.5, the modified ad and answers to deconstruction questions are evaluated for Knowledge/Understanding, Inquiry, and Making Connections using a rubric.

Activity 1.3: Investigating Science Issues using Media-Based Research

Time: 4 hours

Description

Students are introduced to media-based investigations. They investigate fact, opinion, and bias in science-related media and develop a checklist to be used to evaluate the information sources used for investigation. Students practise oral and listening skills as they participate in rich peer discussions. Gathering information to analyse an issue first in the role of a stakeholder on one side of the issue, and finally as a reporter from the other side, they are introduced to the Making Judgements Master Form they will use throughout the course to analyse scientific issues.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE2e - uses and integrates the Catholic faith tradition, in the critical analysis of the arts, media, technology and information systems to enhance the quality of life;

CGE3f - examines, evaluates, and applies knowledge of interdependent systems (physical, political, ethical, socio-economic, and ecological) for the development of a just and compassionate society;

CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills.

Strand(s): Scientific Inquiry: Science in Media

Overall Expectations

SIMV.02 - investigate science-related information presented in print and electronic media using appropriate research and reporting skills;

SIMV.03 - evaluate claims and presentations of science-related information in media.

Specific Expectations

SIM2.02 - research science-related information from a variety of electronic and other sources;

SIM2.03 - interpret research data, including analysis for accuracy and bias as appropriate, using a range of strategies for reading for information;

SIM2.04 - organize and communicate information collected from lab investigations and information research using graphic organizers;

SIM3.02 - develop procedures to assess these claims and representations, using information research and/or laboratory investigations.

Prior Knowledge & Skills

- Understanding of target audience in the media
- Knowledge of computers, web-based navigation, and basic technological skills

Planning Notes

- Work with other departments for this unit; suggestions include Physical Education (issues for discussion), the Mathematics Department (support reading graphic text), and particularly the English Department (support reading informational and graphic text, analysis of fact, opinion and bias).
- This activity may be appropriate for Ontario Secondary School Literacy Test (OSSLT) practice, if the course is delivered in the first semester, as it emphasizes reading skills. The Making Judgements Master Form could be used for students to develop an opinion piece. Note that the term Master Form is a workplace term for template.
- When choosing websites to bookmark for students, make sure to check all links for appropriateness.

1.3.1 Fact, Opinion, and Bias

- Collect brochures, posters, articles, and/or advertisements of science-related issues (health, environment) that are directed to different audiences and have different purposes.
- Prepare concept attainment activity for fact and opinion (Appendix 1.3.1: Concept Attainment Sentences for Fact and Opinion).
- Provide copies of paragraphs with bias that include both facts and opinions that students can highlight.

1.3.2 Preparing for Research

- Choose a science-related issue for debate, being sensitive to how students may react. It should have clearly defined stakeholders, e.g., a local or current campaign for a health, social, environmental issue, that involves verifiable facts. Teachers should be aware of their own biases and ensure that students feel free to make personal decisions about the issue.
- Prepare information pieces that students use for the research – web pages, library search, search town halls, experts, etc. – with direct, indirect, and connecting-to-text questions. Students struggling with reading could conduct an interview with an expert. Contact the school librarian in advance to assist in searching for media for the issue investigation, in addition to Internet resources and prepared bibliography templates.
- Copyright issues for research can be contrasted with those of the music/video industry, e.g., ideas can be used if the source is acknowledged; music or video cannot be copied or you don't have to buy the research book; you do have to buy the music or video to avoid breaking copyright law.
- Identify mixed-ability level groups for the website evaluation activity. Check the Resources and direct students to appropriate activities on evaluating websites. Inform student of board/school Internet policy. If students have had little experience with web-based research, ensure that they are made aware of security and safety issues (see Resources).
- Prepare the model reading with before-, during-, and after-reading strategies.

1.3.3 Preparing for Research

- Prepare graphic organizers and focus questions for the investigations including direct, indirect and connecting-to-text questions.
- Prepare Making Judgements Master Forms with the roles of A and B clearly identified for each student. Refer to *Think Literacy*: “Responding to Reading – Making Judgements (Both Sides Now), p. 77.

Teaching/Learning Strategies

1.3.1 Fact, Opinion, and Bias

- The teacher reviews the intended audience and the purpose of persuasive articles, brochures, or posters from science (environmental, health related).
- The teacher leads a concept attainment exercise (Appendix 1.3.1: Concept Attainment Sentences for Fact and Opinion) for students to construct definitions of fact and opinion.
- In groups, students analyse short paragraphs for fact, opinion, and bias using a graphic organizer or chart with the headings: Statement, Fact/Opinion, Bias, Reasoning. The concept of writing for an audience is contrasted with the possibility of bias due to the author's interest and purpose. The paragraphs contain claims that students might have to research from various sources to verify facts or question opinions. Students brainstorm where they might find the information.
- Students participate in a teacher-led discussion on sources of information for research, being sure to include personal experts – professional and business; government – municipal, provincial, federal; school and local libraries; movies; TV; radio. Students will not be aware of all the information that may be available to them. The discussion should include these. Students should keep a record of sources of information in their portfolio for future reference.

1.3.2 Preparing for Research

- Students are introduced to a science-related issue to research. They write a reflection on their personal response to the issue and which side they support, and why.
- The teacher reminds students of copyright. Students are given a short exercise in how to record information and a bibliography template for the portfolio.
- The teacher shows students a website that contains graphics and informational text about the science-related topic. The teacher models some specific strategies for before, during, and after reading for students to use when gathering information from their websites.
- Students participate in an online activity to evaluate websites. The teacher monitors progression of the activity and uses the information to complete the information pieces that students use to examine the issue.
- The teacher leads a discussion about the appropriateness of the criteria for evaluating media information used for this science investigation. Students prepare a checklist that they will use for evaluating the sources of science information they will be directed to for investigation.

1.3.3 Accessing Resources

- In pairs, students collect information using graphic organizers from single websites bookmarked by the teacher or from other provided informational media. Students note which reading strategies they use for the activity.
- Reading pairs are designated A and B. Two pairs of students collect information independently from the same source. This reduces the number of sources required, and allows students some time to review the information gathered for completeness and accuracy.
- Students use their evaluative checklist prepared in activity 1.3.2 independently to rate the source of their information.
- The two pairs who read the same source meet to compare their information and ensure that it is correct.
- Students are given a prepared Making Judgements Master Form and are assigned a stakeholder role that puts them on one or the other side of the issue. All A's will be stakeholders one side; all B's will be stakeholders on the other side. Students select good arguments for their side of the issue from their information.
- Students gather information from other groups that may help them argue their stakeholder side of the issue. Sources must be acknowledged on the sheet. One pair of A's and B's will move to collect information from other groups, while the second pair stays at the station to share their information. The roles reverse so that the second pair can pick up the information they need from other groups. At the end of information gathering, all students have a Making Judgements Master Form with only one side full of information.
- Students submit their completed evaluative checklist and graphic organizer for assessment.

1.3.4 Processing Information

- Students participate in a timed, paired, tell/retell activity. Students are grouped in different A/B pairings than were used in activity 1.3.3. A's have a specified time (one or two minutes) to tell their side of the argument, recorded on one side of their Making Judgements Master Form. B's listen to A's arguments and record them on the blank side of their Making Judgements Master Form. When group A is finished, B's have the same amount of time to retell what they heard to make sure they got it right. Then B's have the same specified time to tell their arguments, while A's make notes. A's then retell in the specified time. At the end of the tell/retell, students should have a completed the Making Judgements template with both sides full of information. Teachers continue to observe social skills during the activity.

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- Students are regrouped into manageable groups of all A's and all B's. A's record what they heard from B's on chart paper. B's record what they heard from A's on chart paper. Each group chooses the three best pieces of information that support the stakeholder's side of the issue and draw stars next to them. These ideas are shared, e.g., posted, oral presentation.

1.3.5 Transferring Learning

- Students use the class charts to add to both sides of their Making Judgements Master Form.
- Students make a personal decision about the issue researched with reasons based on the information they have collected.
- Students submit a completed Making Judgements Master Form for assessment.
- Students participate in a teacher-led reflection on the research process: Preparing for Research, Accessing Resources, Processing Information, and Transferring Learning, which is added to the portfolio and compared to the experimental process of Activity 1.1.
- Students complete a reflection for their portfolio on whether their opinion of the issue was different to the one they held before the activity, and on how well they worked in pairs and in groups.

Assessment & Evaluation of Student Achievement

See Assessment & Evaluation of Student Achievement in Overview, p. 8.

- In activity 1.3.1, student understanding of fact, opinion, and bias is assessed, through observation.
- In activity 1.3.2, student technology skills are diagnostically assessed for future consideration.
- In activity 1.3.3, the evaluation checklist and the graphic organizer are assessed for Inquiry and Making Connections using a checklist.
- In activity 1.3.4, student social skills are diagnostically assessed, through observation.
- In activity 1.3.5, the completed Making Judgements Master Form is assessed for Making Connections using a checklist.

Resources

Science Resources

Print

From Both Sides: Module 1: Use of Pesticides Grades 7-12. Milton, ON: Ontario Agri-Food Education Inc., 1997.

Websites

Instructional Materials in Science Education (IMSENet) – <http://www.ncsu.edu/imse/index.htm>

Literacy Resources

Print

Ontario Ministry of Education. *Think Literacy.* Toronto, ON: Queen's Printer, 2003. ISBN 077945426X

Sejnost, Roberta and Sharon Thiese. *Reading and Writing Across Content Areas.* Glenview, IL: Skylight, 2001. ISBN 157517362X

Tovani, Cris. *I Read It But I Don't Get It.* Portland, ME: Stenhouse, 2000. ISBN 157110089X

Teaching and Learning Resources

Print

Barton, Mary Lee and Deborah L. Jordan. *Teaching Reading in Science.* Aurora, CO: McREL, 2001. ISBN 1893476030

Bennett, Barrie and Carol Rolheiser. *Beyond Monet.* Toronto: Bookstation, 2001. ISBN 0969538839

Coping with the New Curriculum: The School Library Information Centre Collaborating for Success. Toronto, ON: Educational Services Committee OSSTF, 2001. ISBN 0-920930-81-6

Harvey, Stephanie and Anne Goudvis. *Strategies that Work: Teaching Comprehension to Enhance Understanding.* Markham, ON: Pembroke, 2000. ISBN 1571103104

Koechlin, Carol and Sandi Zwaan. *Information Power Pack.* Markham, ON: Pembroke, 1998. ISBN 1551380862

Koechlin, Carol and Sandi Zwaan. *Infotasks for Successful Learning.* Markham, ON: Pembroke, 2001. ISBN 1551381338

Ontario School Library Association. *Information Studies: Kindergarten to Grade 12: Curriculum for Schools and School Library Information Centres.* Toronto, ON: OLA, 1999.

Websites

Canada's School Net – www.schoolnet.ca

Evaluating Internet Resources: A Checklist – <http://www.infopeople.org/howto/bkmk/select.html>

Evaluating Web Pages: A WebQuest – <http://mciunix.mciu.k12.pa.us/~spjvweb/evalwebteach.html>

CyberSense and Nonsense: The Second Adventure of the Three CyberPigs (Media Awareness Network) – http://www.media-awareness.ca/english/special_initiatives/games/cybersense_nonsense/index

Hoax? Scholarly Research? Personal Opinion? You Decide! (Media Awareness Network) – <http://www.media-awareness.ca/English/resources/educational/lessons/secondary/Internet>

Jo Cool or Jo Fool (Media Awareness Network) – http://www.media-awareness.ca/English/special_initiatives/games/joecool_joefool/index

K-12 Information Literacy in the Digital Age Resource List – http://ww4.fsusd.k12.ca.us/education/infolit/K12-infolit_links.htm

Kathy Shrock's Guide for Educators – <http://school.discovery.com/schrockguide/eval.html>

Kid's Click! – <http://www.rcls.org/wows/>

Knowing What's What and What's Not: The 5 Ws (and 1 H) of Cyberspace (Media Awareness Media Awareness Network) – http://www.media-awareness.ca/English/resources/special_initiatives/wa_resources/wa_shared/tipsheets/5ws_of_cyberspace.cfm

QUICK: The Quality Information Checklist – <http://www.quick.org.uk/menu.htm>

Ready Reference Sources (Southern Ontario library Service) – www.library.on.ca/information/ref-index.html

Resources for Catholic Teachers

CD-ROMs

Curriculum Support for Catholic Schools. Eastern Ontario Catholic Curriculum Cooperative, 2002.

Appendix 1.3.1: Concept Attainment Sentences for Fact and Opinion

Concept Attainment is a game in which students develop their own definitions for words and thus internalize the concepts from examples that make sense to them. In this case, there are two concepts to be understood: fact and opinion. It is suggested that teachers develop the concept of fact to include:

- events that have actually occurred;
- information that is exact and provable;
- information that is specific and accurate.

Without giving the word *fact*, the teacher provides a series of statements that are facts and a series of statements that are not facts and asks the students to develop a definition for the unknown concept or word. Students examine these either individually, in pairs, or in groups. Once they think they understand the concept, the teacher provides some test statements for students to sort into the Is category or the Is Not category. Students can answer these by hand signals so that the teacher can determine whether more examples need to be provided. It is important that examples are drawn from students' local experiences. When students can classify the test statements, they are ready to develop definitions. Once the concept of fact is well defined, then opinions can follow. The method is well explained in Bennett and Rolheiser's *Beyond Monet* (see Resources).

Unit 2: Biology: Living Together

Time: 25 hours

Unit Description

Living in a community presents challenges for and benefits to all living things – plants, animals, and humans. By observing examples from nature, students make connections to their role as responsible members of the world community.

Students are introduced to the biological concept of population, focusing on the benefits and challenges of organisms of the same species living together. They investigate and report on the problems that arise when populations of microscopic organisms become overcrowded. Through the study of a pond, field, or other biological community, students see that natural populations do not exist in isolation and relate their observations to human populations. Students refine laboratory skills while investigating population growth and structure using larger organisms. These investigations become the basis for the school-based action plan developed in Unit 5 and in the Final Course Evaluation.

Unit Synopsis Chart

Activity/ Time	Learning Expectations	Assessment and Evaluation Categories, Tasks, and Tools	Tasks
2.1 Benefits and Challenges of Living Together 4 hours	BLTV.01, .02, BLT1.01, 1.02, 1.03, 1.04, 2.06 SIMV.02, SIM2.02, 2.04 CGE2a, 2b	2.1.3: Graph evaluated for Communication using a rating scale.	Students: <ul style="list-style-type: none">• answer a general yes/no/not applicable survey to develop an awareness of the benefits and challenges of humans living together in communities;• discuss, as a class, answers to survey and complete a Plus/Minus table;• create a Biology Terminology Licence; match drawings/diagrams to terms to improve understanding;• play a game that introduces aspects of intraspecific competition over a series of ‘generations’;• plot population data on a graph and analyse;• view and read case studies and answer questions.

Activity/ Time	Learning Expectations	Assessment and Evaluation Categories, Tasks, and Tools	Tasks
2.2 Investigating Populations of Microscopic Organisms 7 hours	CIMV.02, CIM2.01 BLTV.02, .03, BLT2.01, 2.03, 2.06, 3.01 SIMV.03, SIM3.04 CGE4f, 5a, 7i	2.2.1: Mastery of microscope skills assessed using a checklist 2.2.2: Diagnostic 2.2.3: Observations and diagram evaluated for Inquiry and Communication using a rubric. 2.2.4: Data table is evaluated for Communication and the analysis questions are evaluated for Inquiry using a checklist. Graph is evaluated for Communication using a checklist, and the analysis questions are evaluated for Inquiry using a rubric. 2.2.5: questions and the poster are evaluated for Making Connections and Communication.	Students: <ul style="list-style-type: none"> • review/are introduced to microscope and biological diagrams; earn a “Microscope Licence”; • reinforce/acquire microscope scanning technique by playing a game with the use of an overhead projector; • examine a depression slide containing a sample of a microscopic aquatic community; • make simple qualitative observations and draw a biological diagram of a species within the sample; • investigate overcrowding in yeast populations; • conduct an investigation to monitor the population of a yeast suspension over a number of days; • read a case study describing a local environmental concern relating to microscopic organisms; • develop a simple action plan of five suggestions to deal with the concerns described in the case study; • design and create posters based on their action plan to appeal to and motivate their peers to act toward correcting the problem.
2.3 Investigating Populations of Macroscopic Organisms 5 hours	BLTV.01, .02, BLT1.02, 1.03, 2.02, 2.05, 2.06 SIMV.02, SIM2.04 PEEV.02, PEE2.05 CGE2b, 3e, 4f	2.3.1: Graph is evaluated for Communication using a checklist 2.3.2: Diagnostic 2.3.3: Help Wanted ads evaluated for Knowledge/ Understanding and Communication using a rubric	<ul style="list-style-type: none"> • Students: plan and conduct an investigation of intraspecific competition in plants; • complete ongoing observations to compare rates of plant success and growth in a variety of spacing situations; • complete interviews within their household to determine the roles played by various individuals; • choose and research an animal that displays a distinct social behaviour; • create Help Wanted ads to advertise for positions found within the populations.

Activity/ Time	Learning Expectations	Assessment and Evaluation Categories, Tasks, and Tools	Tasks
2.4 School Environmental Issue Action Plan 9 hours	BLTV.01, .02, .03, BLT1.02, 2.04, 3.01, 3.02 SIMV.01, .02, SIM1.01, 1.02, 1.03, 2.02 CIMV.02, CIM2.01, 2.05 PEEV.02, PEE2.05 CGE2a, 2b, 2c, 2d, 7i, 7j	2.4.1: Diagnostic submitted for teacher approval 2.4.2: Design of investigation and observations evaluated for Inquiry 2.4.4: Action plan and media piece evaluated for Communication and Making Connections	Students: <ul style="list-style-type: none"> • formulate a proposal after taking a teacher-guided walk; • conduct an investigation approved by their teacher to collect data regarding their environmental concerns; • use a variety of media resources to determine the environmental policies currently in place; • organize media-based research and investigation data to develop and support a simple action plan; • design and produce a media piece of her/his choice that communicates/advertises his/her action plan.

Activity 2.1: Benefits and Challenges of Living in Communities

Time: 4 hours

Description

Students start by answering questions from a simple survey to increase awareness of the benefits and challenges of humans living together in communities. As a class, the information in the survey is used for a brainstorming activity to create a Plus/Minus table to which students refer throughout the unit. The goal is to make students feel as though the ideas studied in this unit are relevant to them. Students complete a Biology Terminology Licence (BTL) to emphasize the importance of learning new vocabulary terms. Students are given the key terms, define them in their own words, and illustrate them where appropriate. The BTL is placed in the portfolio and used during other activities. To demonstrate the concept of competition for resources and population fluctuation, students participate in a game in which they act as either deer or a resource. This activity introduces aspects of intraspecific competition over a series of 'generations.' Each generation's population data is plotted on a graph. Graphs are analysed to establish patterns. Finally, students view, then read case studies that outline the benefits of individuals living together. Students answer a series of questions that relate to each case study.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE2a - listens actively and critically to understand and learn in light of gospel values;

CGE2b - reads, understands and uses written materials effectively.

Strand(s): Scientific Inquiry: Science in Media; Biology: Living Together

Overall Expectations

SIMV.02 - investigate science-related information presented in print and electronic media using appropriate research and reporting skills;

BLTV.01 - explain the strategies that organisms use for successful coexistence in populations and communities;

BLTV.02 - investigate, using appropriate laboratory and research skills, the implications of organisms existing in communities.

Specific Expectations

SIM2.02 - research science-related information from a variety of electronic and other sources;

SIM2.04 - organize and communicate information collected from lab investigations and information research using graphic organizers;

BLT1.01 - summarize the potential benefits of organisms living together in communities;

BLT1.02 - identify challenges that arise from organisms living together in communities, including human populations;

BLT1.03 - compare the strategies used by various communities of organisms to successfully coexist;

BLT1.04 - use appropriate terminology related to concepts of organisms living;

BLT2.06 - explain and interpret observations by summarizing patterns obtained from graphing data, organizing information, and communicating orally and in writing.

Prior Knowledge & Skills

- Experience formulating plus/minus tables in Unit 1
- Knowledge of ecological concepts (Grade 7)
- Experience creating terminology lists in other units and grades
- An understanding of the definition of *resource* from activity 2.1.2
- Experience graphing data from Unit 1
- Experience with computer use and Internet searches from Grade 9 and/or Unit 1

Planning Notes

2.1.1 Survey and Plus/Minus Table

- A survey of yes/no questions regarding the benefits and challenges of living together in communities should be prepared ahead of time.
- A plus/minus table to record the benefits and challenges should be prepared ahead of time.

Note: Teachers must be aware of cultural and social-economic sensitivities relating to living arrangements when they are creating the questions and discussing survey answers.

2.1.2 Biology Terminology Licence

- Teachers may consider having copies of diagrams/clip art available that students can match to new terms in the BTL.
- Refer to course Resources for suggestions for creating deeper understanding when studying terminology.

2.1.3 Oh Deer! Game

- A gymnasium or other open space should be booked in advance to allow an alternate location for the game if weather limits students playing the game outside.
- The game should only be played in an open space to avoid injury.
- Prior to playing, a table should be drawn on a piece of chart paper to record the number of deer and resources at each generation. A student or the teacher may record the data.
- Two ropes or skipping ropes are used as boundaries during the game.
- This game is described in many locations and on the Internet. For modifications and more detailed descriptions please view available websites (see Resources).
- The game can be modified to accommodate students who have special needs with respect to locomotion.

2.1.4 Case Study – So Happy Together!

- Teachers may want to book a computer lab or library for this lesson in order to allow students to research animals/plants in which they are interested.
- Students should be provided with specific URLs to use during their Internet search (see Resources).
- Depending on availability, some teachers may want to begin with a video that portrays some advantages of certain species living together.
- The teacher may wish to provide two case studies rather than allow students to search for one using the computer.
- Accommodations include extended time limits, reduced/uncluttered format, and the rewording/rephrasing of information.

Teaching/Learning Strategies

2.1.1: Survey and Plus/Minus Table

- Students individually complete a simple survey that leads them to consider the benefits and challenges of humans living in communities.
- The teacher directs a class discussion in which students share information from their surveys to complete a plus/minus table that emphasizes the benefits and challenges of humans living together in communities.

2.1.2: Biology Terminology Licence

- Students receive a list of key biology terms to include in their BTL, e.g., individual, population, community, species, benefit, challenge, resource, microscopic, macroscopic, colony, coexistence, biodiversity.
- Students define as many terms as possible using text, notes, and teacher assistance, while being encouraged to put definitions in their own words.
- Students draw diagrams for new terms or match diagrams provided by the teacher.
- This activity continues throughout the unit each time a new term is introduced.

2.1.3: Oh Deer! Game

- Students are divided into two equal groups; one group will become the ‘deer,’ the other group will become the ‘resources.’
- The two ropes are placed parallel to each other, approximately 10 metres apart on the ground/floor (depending on space). The deer line up behind one line while the resources line up behind the other with their backs to the deer.
- Three hand signals are used by the deer and resources; food is shown by placing a hand over the stomach, water is demonstrated by placing a hand over the mouth, and shelter is shown by placing the hands on the head.
- The deer and resources stand with their backs to each other; the deer decide what resource they need and make the appropriate hand signal, while the resources decide what resource they are and make the appropriate hand signal.
- On teacher signal, the deer and resources turn and face each other; the deer then move to the resource side to find a resource matching their hand signal. When they find the proper resource they take them by the hand and bring them back to their side where the resource becomes a deer. Any deer that cannot find a matching resource does not survive that generation and becomes a resource.
- The game is repeated for many generations (suggest 20 generations, each generation taking approximately one minute). After each generation the number of deer and “resources” are recorded on chart paper.

-
- The teacher or students can suggest certain modifications, such as a drought, in which none of the resources is water; these modifications should be recorded and used for analysis when graphing.
 - Students return to class, copy the data table created during the game, and create a population vs. generation graph for the deer.
 - Students then answer analysis questions using their graph. Suggested questions include:
 - The deer population appears to fluctuate; what does this mean?
 - When the deer population increased, what happened to the number of resources?
 - Identify one place in the graph where the deer population grew; suggest two reasons this could have occurred.
 - Identify one place in the graph where the deer population decreased; suggest two reasons this could have occurred.

2.1.4: Case Study – So Happy Together!

- Students view a video displaying an animal population that benefits from living together. Students answer questions relating to this case study (see Resources).
- Students may search provided URLs on the Internet for a specific animal/plant they are interested in and answer questions regarding benefits of this species living together.

Assessment & Evaluation of Student Achievement

See Assessment & Evaluation of Student Achievement in Overview, p. 8.

- In activity 2.1.3, the graph is evaluated for Communication using a rating scale (see Appendix 2.1.1: Sample Graph Communication Evaluation Rating Scale).

Resources

Science Resources

Websites

African Wildlife Foundation – <http://www.awf.org/gorillaupdate/>

The Teacher Net Gazette, Oh Deer – <http://teachers.net/gazette/MAY02/stanimirovic2.html>

Video

Private Lives of Dolphins. VHS. Nova, 2001. 60 minutes.

Resources for Catholic Teachers

Print

Catechism of the Catholic Church. Publication Services. Canadian Conference of Catholic Bishops, 1994. ISBN 0-88997-281-8

Websites

Eastern Ontario Catholic Curriculum Cooperative – <http://www.eoccc.org>

Faith and the Common Good – <http://www.faith-commongood.net>

Appendix 2.1.1: Sample Graph Communication Evaluation Rating Scale

Category	Mark		
Appropriate title on graph, at top and underlined	0	1	2
Graph done in pencil (or coloured pencils, where appropriate)	0	1	
Appropriate scale used on y-axis	0	1	
Appropriate scale used on x-axis	0	1	
Points plotted correctly	0	1	2
Y-axis labelled with correct units included	0	1	2
X-axis labelled with correct units included	0	1	2
Independent variable on the x-axis	0	1	
Dependent variable on the y-axis	0	1	
Key included (if needed)	0	1	
TOTAL			

Activity 2.2: Investigating Populations of Microscopic Organisms

Time: 7 hours

Description

Students review/are introduced to microscope parts and their functions, microscope care and storage, focusing technique, depression slide procedure, and biological diagrams. Students draw a simple diagram of an image from a prepared slide of a ruler as viewed under low power. Following the preparation of a depression slide, students draw a diagram of an image as viewed under medium or high power. All skills are assessed towards a Microscope Licence which is placed in the student's portfolio. The skills obtained in these tasks are used in activities 2.2.3 and 2.2.4. Students then gain experience with the movement of a slide and scanning technique when using a microscope by playing Goofy Golf. Students use skills developed in the first two activities to prepare a depression slide of a microscopic aquatic community. Students view this slide under a microscope while making simple qualitative observations and drawing a biological diagram of one organism they find on their slide. The idea that populations do not exist in isolation is emphasized. Students study overcrowding in a microscopic population through observation of a yeast suspension. Over a number of days students make observations of the amount of gas ($\text{CO}_2(\text{g})$) formed in the suspension. This data is analysed. Simultaneously, the class plans and students conduct an investigation in order to measure the size of a yeast population over a number of days. Students retrieve a yeast suspension sample daily and observe under appropriate power in order to count the number of yeast in the field of view. This data will be collected in a table, graphed, and analysed. Finally, students read a case study describing an issue relating to a microscopic population, e.g., public beach closure or drinking water quality problem due to *E. coli*. Students answer a series of questions that relate to the case study. Students develop a simple action plan of five suggestions to deal with the concerns described in their case study. Students design and create posters based on their action plan to appeal to and motivate their peers to act toward correcting the problem.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills;

CGE5a - works effectively as an interdependent team member;

CGE7i - respects the environment and uses resources wisely.

Strand(s): Scientific Inquiry: Science in Media; Chemistry: Interactions of Common Materials;
Biology: Living Together

Overall Expectations

SIMV.03 - evaluate claims and presentations of science-related information in media;

CIMV.02 - investigate the types and rates of interactions between commonly used materials through laboratory activities;

BLTV.02 - investigate, using appropriate laboratory and research skills, the implications of organisms existing in communities;

BLTV.03 - analyse the challenges that arise from organisms living in communities.

Specific Expectations

SIM3.04 - communicate science-related information to a workplace audience by creating a media work;

CIM2.01 - select and use appropriate apparatus and apply WHMIS safety procedures for the handling, storage, disposal, and recycling of laboratory materials;

BLT2.01 - plan and conduct an experiment to investigate the results of overcrowding in microscopic populations, including estimation and measurement of population size;

BLT2.03 - make accurate observations of the organisms that exist in a community, using a microscope;

BLT2.06 - explain and interpret observations by summarizing patterns obtained from graphing data, organizing information, and communicating orally and in writing.

BLT3.01 - develop an action plan, using a consistent written format, to address an environmental concern.

Prior Knowledge & Skills

- Experience using a microscope from Grade 9
- Experience with the terms *community*, *individual*, *species*, and *population*
- Experience with graphing and analysing data from activity 2.1.3
- Experience reading case studies and answering questions from activity 2.1.4

Planning Notes

2.2.1 Obtaining a Microscope Licence

- Depending on the courses taken by the students prior to this course, their backgrounds will vary greatly. Therefore some students with more experience may renew their licence and help less experienced students.
- The teacher consults the microscope resources provided to create a microscope skills checklist of the skills they wish their students to have when using a microscope (see Appendix 2.2.1: Sample Teacher Checklist for Students Earning a Microscope Licence).
- Teachers should ensure that the microscope diagram labelled is identical to the microscope used in the classroom to avoid confusion, i.e., not a standard diagram from a text.
- A prepared slide of a ruler was chosen for the biological diagrams under low and medium power to give students an idea of the amount of actual space being viewed on the slide when using these lenses.

2.2.2 Goofy Golf

- Prior to this lesson, the teacher should prepare three to five overheads that can be used as 'golf courses' (see Appendix 2.2.2: Sample Goofy Golf Course). The overheads should contain the numbers 1-7 written randomly in permanent overhead marker.
- Students trying this activity will not have had the opportunity to learn by watching their peers. This should be explained to the class. Students should be given the opportunity to volunteer to go first.

2.2.3 What's in a Drop of Pond Water?

- Depending on location, teachers may wish to organize a field trip to obtain a pond water sample.
- If possible, students may collect water samples from a nearby pond, stream, etc.
- A pond water sample may be obtained from an eco-bottle (a small, self-sustaining ecosystem in a jar) found in the classroom or a prepared hay infusion (see Resources).
- Culture tubes containing slides at the end, e.g., Demo Microscope Slides, Ready Slides, may be used, if available, to prevent damage to the specimen.
- A hay infusion can be used to increase the number of visible microorganisms in a pond water sample (See Resources).

2.2.4 Investigating Yeast Populations: Overcrowding and Measuring/Estimating Population Size

- Consider allergies to yeast.
- The teacher tests the yeast sample before the experiment to determine viability and activity level.
- Students must be taught that yeast are microscopic organisms that produce a gas when active. This gas can be collected.
- Part A: If time allows, each student performs the overcrowding lab rather than the teacher performing a demonstration.
- Part B: The teacher prepares the yeast suspension by mixing 1 g of dry active yeast and 100 mL of 10% sucrose solution in a 250 mL Erlenmeyer flask.

-
- The teacher may want to dilute the yeast suspension to make it easier to count cells; if so, this should be done ahead of time.
 - Depending on available equipment, the teacher may wish to collect a yeast sample, place it under a microscope, and view it with the class on a screen using a videoscope in order to demonstrate a method of counting yeast.
 - If a spectrophotometer is available, teachers may wish to use it rather than counting individual yeast cells. This will require an explanation of the principle behind this method of collecting data.

2.2.5 Case Study – Tiny but Troublesome!

- The teacher may wish to choose a topic that is relevant to the area of the school, e.g., local water concerns or beach closures.

Teaching/Learning Strategies

2.2.1 Obtaining a Microscope Licence

- Students complete a series of tasks to earn a Microscope Licence that will be placed in their portfolio. See Appendix 2.2.1: Sample Teacher Checklist for Students Earning a Microscope Licence for a sample checklist of skills necessary to earn this licence.

Part A:

- Students label a diagram of a microscope; learn basic function, care, and storage.
- Students demonstrate skills (as the teacher uses a checklist) to earn Microscope Licence Part A.

Part B:

- Students learn general focusing technique using the coarse adjustment knob first followed by the fine adjustment knob, while ensuring that the objective lens does not touch the slide.
- Students demonstrate their skills (as the teacher uses a checklist) to earn their Microscope Licence Part B.

Part C:

- The teacher provides a list of rules for proper biological drawing and models these rules to show how they are applied. Students make a biological drawing of a common object, e.g., watch, calculator, stove, to practise the use of the rules. These drawings are peer assessed.
- Students then use skills from Part B to focus a prepared slide of a ruler on low and medium power and draw diagrams using proper technique.
- Students hand in their diagram (as the teacher uses a checklist) to earn their Microscope Licence Part C.

Part D:

- Students learn how to prepare a depression slide by viewing teacher demonstrations.
- Students demonstrate their skills by preparing a depression slide of coloured water (as the teacher uses a checklist) to earn their Microscope Licence Part D.

Note: Slides should not be placed on the microscope stage; this activity is done to assess the ability of the student to prepare a depression slide.

2.2.2 Goofy Golf

- Students take turns going to the overhead to play Goofy Golf, in which they use a non-permanent overhead marker to trace their ‘golf strokes’ from 1–7 without lifting their pen from the overhead. See Appendix 2.2.2: Sample Goofy Golf Course Overhead for a sample overhead for use with this game.
- Students must only look up at the overhead projector and not down at their hand as they make their ‘shots.’

- Students are timed to see how long it takes them to make 7 ‘golf strokes’ and get the ‘ball in the hole.’
- Once the game is complete, the teacher leads a discussion on how this game demonstrates that when scanning a microscope slide, it appears to move in the opposite direction to which it is being pushed.

2.2.3 What's in a Drop of Pond Water?

- Students prepare a depression slide of the microscopic aquatic community using their Microscope Licence Part D for guidance. A few drops of gelatin or methyl cellulose are added to the water to slow the microorganisms for better viewing.
- Students are given diagrams of microorganisms commonly found within pond water (see Resources).
- Students scan their slide to find various microorganisms and use their diagrams to identify them. Students complete a table containing the columns, e.g., Name of Organism; Does It Move, If So How?; Colour; General Description.
- Students select a specimen that they can see clearly and, using their Microscope Licence Part C for guidance, draw a biological diagram of the specimen viewed with the appropriate objective.

2.2.4 Investigating Yeast Populations: Overcrowding and Measuring/Estimating Population Size

- The teacher leads a class discussion on yeast – how we use it, nutrition requirements, metabolism, and waste products.

Part A: Investigating Overcrowding in Yeast Populations

- Students combine one package of dry yeast, approximately 50 mL of warm water, and 10 g of sugar in a 2 L plastic soda bottle, while placing a balloon over the top of the bottle, sealing it with tape.
- Students monitor the apparatus over the class period, measuring and recording the diameter of the balloon every ten minutes. Students prepare a table to record observations.
- Students leave the apparatus in a warm spot, e.g., the windowsill, but not in direct sunlight, and return the next day to make another diameter measurement. This is continued until the diameter stops increasing.
- Once observations are complete students answer analysis questions. Examples of questions include: When the balloon was blowing up, what was happening to the yeast population? What gas was the yeast releasing? Explain what was happening to the yeast population when the balloon stopped growing. What was the yeast competing for?

Part B: Measuring and Estimating Yeast Population Size

- Students use a pipette to transfer a drop of a yeast suspension prepared by the teacher (see Planning Notes) to a depression slide.
- Students add methylene blue to the sample (dead cells turn blue) and observe the sample under a microscope using appropriate power to count the number of living yeast cells found in the field of view.
- Students repeat the above step for multiple days at the beginning of each class until the population stops growing. **Note:** The use of the same microscope and the same power each day is important to the quality of the data to be collected.
- The data collected is graphed (day vs. yeast population in field of view) and analysis questions are answered regarding the graph.

2.2.5 Case Study – Tiny but Troublesome!

- Students read a case study involving an environmental issue relating to a microscopic community. Students answer questions relating to this case study.
- Students develop a simple action plan of five suggestions to deal with the concerns described in their case study.

-
- Students design and create posters based on their action plan to appeal to and motivate their peers to act toward correcting the problem.

Assessment & Evaluation of Student Achievement

See Assessment & Evaluation of Student Achievement in Overview, p. 8.

- Activity 2.2.1 is assessed using a checklist to ensure the student has mastered microscope skills, a Level 3 (70 - 79%) must be earned in order to obtain the licence. Once this level is achieved the student receives a sticker on the licence document.
- Assessment in activity 2.2.2 is diagnostic.
- In activity 2.2.3, observations and diagram are evaluated for Inquiry and Communication using a rubric.
- In activity 2.2.4, Part A, data table is evaluated for Communication and the Analysis questions are evaluated for Inquiry using a checklist.
- In activity 2.2.4, Part B, the graph is evaluated for Communication using a checklist (see Appendix 2.1.2: Sample Graph Communication Evaluation Checklist), and the analysis questions are evaluated for Inquiry using a rubric.
- In activity 2.2.5, questions and posters are evaluated for Making Connections and Communication.

Resources

Science Resources

Websites

CBC News: Inside Walkerton – <http://www.cbc.ca/news/indepth/walkerton/>

Figures for Identification of Microorganisms – www.goshen.edu/bio/BIOL101/pond/KeyFigures.html

How to Use a Microscope Properly

– <http://shs.westport.k12.ct.us/mjvl/biology/microscope/microscope.htm>

Human Health and the Great Lakes – <http://www.great-lakes.net/humanhealth/lake/ontario.html>

Inquiry-Based Investigations into Pond Water Microorganisms

– http://www.accessexcellence.org/AE/AEC/AEF/1994/doucet_pond.html

Light Microscopes – <http://www.howe.k12.ok.us/~jimaskew/mscope.htm>

Making a Hay Infusion – <http://www.pocketscope.com/Support/slides/hayInfusion.php>

Pond Life Identification Kit

– <http://www.microscopy-uk.org.uk/index.html>

– <http://www.microscopy-uk.org.uk/pond/index.html>

Science Bob, Watch Yeast in Action – <http://www.sciencebob.com>

The Compound Light Microscope

– <http://www.southwestschools.org/jsfaculty/Microscopes/compoundscope.html>

Resources for Catholic Teachers

CD-ROMs

Curriculum Support for Catholic Schools. Eastern Ontario Catholic Curriculum Cooperative, 2002.

Appendix 2.2.1: Sample Teacher Checklist for Students Earning a Microscope Licence

Student Name: _____

PART A: Part of a Microscope, Basic Function, Care, and Storage

Point to the medium power objective lens, coarse adjustment knob, fine adjustment knob, and stage.

Skill Demonstrated	Mark	
Correctly identified: Medium Power Objective Lens	1	0
Correctly identified: Coarse Adjustment Knob	1	0
Correctly identified: Fine Adjustment Knob	1	0
Correctly identified: Stage	1	0

Identify the two different lenses that magnify the specimen.

Skill Demonstrated	Mark		
Correctly identified: Ocular Lens and an Objective Lens	2	1	0

Demonstrate how the microscope should be carried and put away? (*Answer: light turned off, cord wrapped around base, cover placed over microscope, carried with two hands*)

Skill Demonstrated	Mark	
Light is turned off/microscope unplugged	1	0
Cord is wrapped around the base of the microscope	1	0
Plastic cover is placed over the microscope	1	0
Microscope is carried with two hands, with the stage parallel to the floor, and put away carefully	1	0
TOTAL MARK	/10	

PART B: Focusing Technique

Demonstrate how to focus a slide on low power.

Skill Demonstrated	Mark	
Correctly places slide under stage clips on the stage	1	0
Uses low power objective lens	1	0
Starts by focusing with the coarse adjustment knob	1	0
Completes focusing using the fine adjustment knob (does not touch the coarse adjustment knob again)	1	0

Demonstrate how to focus the slide from above on medium power.

Skill Demonstrated	Mark	
Ensures that the specimen is in the centre of the field of view	1	0
Switches to the medium power objective lens	1	0
Focuses only using the fine adjustment knob	1	0
Carefully uses fine adjustment knob while checking to ensure that the objective lens does not touch the slide	1	0
TOTAL MARK	/8	

Appendix 2.2.1: Sample Teacher Checklist for Students Earning a Microscope Licence (continued)

Part C: Biological Drawings

Note: This checklist for biological drawings is a guideline, teachers may use different criteria.

Skill Demonstrated	Mark	
Diagram done completely in pencil (no pen or coloured pencils)	1	0
Shading and stippling done appropriately	1	0
One drawing done per piece of white (not lined) paper	1	0
Only structures that can be seen are drawn, e.g., when using a light microscope golgi apparatus, mitochondria cannot be seen and should not be drawn	1	0
Labels are lined up parallel to each other and to the right of the diagram, using a ruler (none of the lines cross each other)	1	0
Lines leading to labels should touch the middle of the object being labelled where possible, no arrow heads are used	1	0
All labels should be written in singular, not plural, e.g., chloroplast, not chloroplasts	1	0
Spelling of all labels is correct	1	0
Subject of drawing written above diagram	1	0
Magnification written above diagram and to the left of page	1	0
Magnification calculated properly (ocular \times objective)	1	0
Proper field of view written above diagram and to the left of page	1	0
Size of specimen written above diagram and to the left of page	1	0
Size of specimen calculated properly	1	0
Stain used written above diagram and to the left of page (if used)	1	0
TOTAL MARK	/15	

Part D: Preparing a Depression Slide

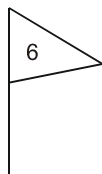
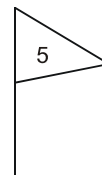
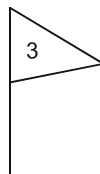
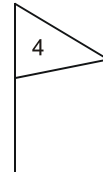
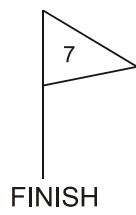
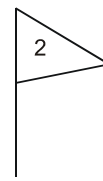
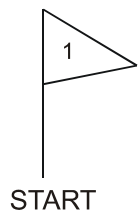
Skill Demonstrated	Mark	
Chooses correct slide from options available (flat and depression)	1	0
Uses a pipette to transfer one to four drops of coloured water to the depression slide	1	0
Places a cover slip carefully over the depression	1	0
Coloured water is not leaking out the sides of the cover slip	1	0
TOTAL MARK	/4	

Note: Depending on the specimen being viewed, some depression slides may be viewed without using a cover slip.

TOTAL MARK ON PARTS A – D	/37
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Student has earned microscope licence (achieved 70% or higher): YES NO

Appendix 2.2.2: Sample Goofy Golf Course Overhead



Activity 2.3: Investigating Populations of Macroscopic Organisms

Time: 5 hours

Description

The class plans and students conduct an investigation of intraspecific competition in plants. Through ongoing qualitative and quantitative observations, students compare rates of plant success and growth in a variety of spacing situations. Students then perform interviews in order to determine the roles of certain people within their household. Once students have an understanding of the various roles played by people in their household, they investigate an animal population. From a list of organisms with high-order social structure, students select one species and conduct media-based research into the various roles within the social structure of that species. A variety of resources may be used (computer, library, etc.). Students prepare a Help Wanted newspaper advertisement for the 'jobs' found within the social structure of the species they have investigated.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE2b - reads, understands and uses written materials effectively;

CGE3e - adopts a holistic approach to life by integrating learning from various subject areas and experience;

CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills.

Strand(s): Scientific Inquiry: Science in Media; Biology: Living Together;
Physics: Using Electrical Energy

Overall Expectations

SIMV.02 - investigate science-related information presented in print and electronic media using appropriate research and reporting skills;

BLTV.01 - explain the strategies that organisms use for successful coexistence in populations and communities;

BLTV.02 - investigate, using appropriate laboratory and research skills, the implications of organisms existing in communities;

PEEV.02 - investigate the factors that affect the generation and use of electricity.

Specific Expectations

SIM2.04 - organize and communicate information collected from lab investigations and information research using graphic organizers;

BLT1.02 - identify challenges that arise from organisms living together in communities, including human populations;

BLT1.03 - compare the strategies used by various communities of organisms to successfully coexist;

BLT2.02 - plan and conduct an experiment to investigate the results of overcrowding in macroscopic populations, including estimation and measurement of population size;

BLT2.05 - use a variety of reading strategies to determine the roles of specific organisms within a community;

BLT2.06 - explain and interpret observations by summarizing patterns obtained from graphing data, organizing information, and communicating orally and in writing;

PEE2.05 - communicate information using appropriate formats for specific purposes and audiences.

Prior Knowledge & Skills

- Knowledge of the factors required for plant growth, e.g., sunlight, water, carbon dioxide, nutrients, space, etc.
- Experience with computer use and Internet searches
- Knowledge of the format used for Help Wanted ads

Planning Notes

2.3.1 Investigating Overcrowding in Plant Populations

- The teacher gathers materials prior to the start of the experiment, i.e., soil, pots, seeds, growth lights.
- It may be beneficial to plant the seeds for this lab at the beginning of the unit to allow the seeds time to grow. When buying seeds, note germination time on package and select accordingly.

2.3.2 Who Does What in Your Household?

- Teachers should be sensitive to the various living situations of their students. As an alternative, students could conduct interviews to determine the various roles within their schools.
- The word *household* has been selected rather than the word *home* in order to include students in many living situations.
- The interviews can be assigned as homework and act as an introduction to the animal investigation.

2.3.3 Help Wanted!

- The computer lab/library should be booked ahead of time for the media-based research.
- Students should be provided with specific URLs to use during their Internet search.
- Teachers can provide good examples of Help Wanted ads found in various local papers.

Teaching/Learning Strategies

2.3.1 Investigating Overcrowding in Plant Populations

- Students grow seeds, e.g., beans, in both ideal and overcrowded conditions (see Resources).
- Students record both qualitative and quantitative observations, e.g., length of stalks, in a table over two weeks.
- Students graph data for both the ideal and overcrowded pots on the same graph (growth day vs. amount of growth in pot).
- they analyse and interpret the data.

2.3.2 Who Does What in Your Household?

- Students complete interviews within their household to determine the roles played by various individuals.
- Using the interview answers as a guide, the teacher leads a class discussion regarding the different roles people play in various situations, and relates this to the roles that animals play within their populations.

2.3.3 Help Wanted!

- Students select an animal that displays a distinct social structure, e.g., ant, bee, whale, dolphin, from a list provided by the teacher.
- Students use the Internet or library to research the various roles found within the population of the chosen animal.
- Students view samples of Help Wanted ads and use them to create Help Wanted ads to advertise for the positions found within the animal populations they researched.

Assessment & Evaluation of Student Achievement

See Assessment & Evaluation of Student Achievement in Overview, p. 8.

- In activity 2.3.1, the graph is evaluated for Communication using a checklist (see Appendix 2.1.1: Sample Graph Communication Evaluation Rating Scale).
- Activity 2.3.2 is diagnostic.
- In activity 2.3.3, Help Wanted ads are evaluated for Knowledge/Understanding and Communication using a rubric.

Resources

Science Resources

Websites

Investigating Space Requirements of Seed Plants

– <http://www.scienceteacherprogram.org/biology/diez1.html>

Activity 2.4: School Environmental Issue Action Plan

Time: 9 hours

Description

Students identify an environmental problem within their school and conduct an investigation to collect data regarding this problem. By referring to earlier activities in this unit, they determine how the problem affects interacting communities or organisms. Students then use a variety of resources to determine the policies already in place to deal with this issue and then organize their research and investigation data to complete an action plan regarding this issue. Finally, students prepare a media campaign to advertise their action plan using a medium of their choice. This task gives students the experience necessary to complete their rich performance task at the end of the course.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE2a - listens actively and critically to understand and learn in light of gospel values;

CGE2b - reads, understands and uses written materials effectively;

CGE2c - presents information and ideas clearly and honestly and with sensitivity to others;

CGE2d - writes and speaks fluently one or both of Canada's official languages;

CGE7i - respects the environment and uses resources wisely;

CGE7j - contributes to the common good.

Strand(s): Scientific Inquiry: Science in Media; Biology: Living Together;

Chemistry: Interactions of Common Materials; Physics: Using Electrical Energy

Overall Expectations

SIMV.01 - explain how science-related information is presented in print and electronic media for different purposes and audiences;

SIMV.02 - investigate science-related information presented in print and electronic media using appropriate research and reporting skills;

CIMV.02 - investigate the types and rates of interactions between commonly used materials through laboratory activities;

BLTV.01 - explain the strategies that organisms use for successful coexistence in populations and communities;

BLTV.02 - investigate, using appropriate laboratory and research skills, the implications of organisms existing in communities;

BLTV.03 - analyse the challenges that arise from organisms living in communities;

PEEV.02 - investigate the factors that affect the generation and use of electricity.

Specific Expectations

SIM1.01 - identify the ways in which scientific information is conveyed;

SIM1.02 - discuss, using examples, how the method of presenting information connects to the purpose;

SIM1.03 - explain how different formats used in the media to present science target specific audiences;

SIM2.02 - research science-related information from a variety of electronic and other sources;

CIM2.01 - select and use appropriate lab equipment and apply WHMIS safety procedures for the handling, storage, disposal, and recycling of laboratory materials;

CIM2.05 - communicate the results of investigations using a variety of oral, written, and graphic formats;
BLT1.02 - identify challenges that arise from organisms living together in communities, including human populations;
BLT2.04 - make observations, directly or using technologies, to determine the benefits and challenges of living in communities;
BLT3.01 - develop an action plan, using a consistent written format, to address an environmental concern;
BLT3.02 - determine, through a case study, and explain how humans organize their communities to address challenges of living together;
PEE2.05 - communicate information using appropriate formats for specific purposes and audiences.

Prior Knowledge & Skills

- Use of skills to perform Internet searches for non-biased information and to summarize information
- Use of skills to perform library searches, locate books, and summarize information
- Experience sourcing information properly from media-based research done in previous units
- Experience creating a simple action plan from Activity 2.2

Planning Notes

- The teacher books a computer lab and/or the library/and consult with the librarian prior to the beginning of this task.
- Students may require Internet passwords and library cards in order to access information.
- Depending on class size and teacher preference, students may work individually, in pairs, or in small groups.

Teaching/Learning Strategies

2.4.1 Preparing a Proposal

- Students take a teacher-guided walk around and within the school to identify environmental concerns associated with school 'life.'
- Students prepare a proposal outlining an environmental problem within the school. The proposal includes identification of the problem and which components of population interactions are affected by this problem. (Students may refer to earlier activities in this unit for reference.) They write a plan for an investigation/activity that identifies and reinforces the concern, and submit it to the teacher for approval.

2.4.2 Data Collection/Investigation

- Students conduct the investigations/activities approved by their teacher to collect data regarding their environmental concerns.

2.4.3 Background Research into Policies Already in Place

- Students use a variety of media resources (computer, library, interviews, school board documents) to determine the policies currently in place regarding the environmental concern they are investigating.

2.4.4 Developing an Action Plan and Media Piece

- Students are exposed to action plans currently in place in their community to act as models.
- Students then organize their media-based research and investigation data to develop and support a simple action plan that addresses the environmental concern they researched.
- Students are exposed to a variety of media formats that exemplify aspects of environmental campaigns.
- Students design and produce a media piece of their choice, e.g., webpage, poster, video commercial, that communicates/advertises the action plan and why action is needed. All pieces are used as part of a class/school media (public awareness) campaign.

Assessment & Evaluation of Student Achievement

See Assessment & Evaluation of Student Achievement in Overview, p. 8.

- Activity 2.4.1 is diagnostic; submitted for teacher approval.
- In activity 2.4.2, design of investigation and observations are evaluated for Inquiry.
- In activity 2.4.4, the action plan and media piece are evaluated for Communication and Making Connections.

Unit 3: Chemistry: Interactions of Common Materials

Time: 26 hours

Unit Description

Using the various forms of media, students develop an awareness of the multitude of common chemical compounds found in everything they use and consume in their everyday lives. They understand and investigate the interactions among compounds and practise literacy skills by appropriately communicating the information learned. Students classify chemicals found in common materials through examination of Household Hazardous Product symbols (HHPs) and Workplace Hazardous Materials Information System (WHMIS) labels found at home, at work, and in the laboratory. They learn and apply different classifications of physical and chemical interactions through research and laboratory activities. Students examine factors that affect rates of chemical and physical interactions qualitatively, through several laboratory investigations. Investigative skills are revisited in the final culminating activity in Unit 5 through the research of environmental impacts. In the unit, students plan, conduct, and communicate the results of an investigation that compares both synthetic and natural materials and their effects on the environment.

Unit Synopsis Chart

Activity/ Time	Learning Expectations	Assessment and Evaluation Categories, Tasks, and Tools	Tasks
3.1 Identifying and Understanding Chemicals Found in the Home and Workplace 5 hours	CIMV.01, .02, CIM1.01, 1.02, 2.01, 2.05 SIMV.01, .02, .03, SIM1.01, 1.03, 2.03, 3.04 CGE2b, 2c, 2d, 2e	3.1.3: The information organized in a chart is assessed for Knowledge/Understanding and Communication using a checklist. 3.1.4: The label done by students individually is evaluated for Inquiry, Making Connections, and Communication using a rubric.	Students: <ul style="list-style-type: none">• identify the chemicals found in household and workplace products by identifying these from the labels and organizing them in a chart;• interpret the chart to classify chemicals based on their use;• review Material Safety Data MSD sheets and identify components found therein;• classify chemicals based on their behaviour;• work cooperatively to create a label;• create their own label.
3.2 Physical Processes and Chemical Reactions 9 hours	CIMV.01, .02, .03, CIM1.03, 2.01, 2.02, 2.03, 3.01 SIMV.02, SIM2.02, 2.04 CGE5d, 7i	3.2.1: Safety rules are evaluated for Knowledge/Understanding using a checklist. 3.2.2: Algorithm is evaluated for Communication and Making Connections using a rubric. 3.2.4: Selection and analysis and Patent Application are evaluated for Knowledge/ Understanding and Making Connections using a checklist.	Students: <ul style="list-style-type: none">• use a series of diagnostic tools to activate prior knowledge about laboratory safety and the properties of matter;• perform a series of investigations to understand the characteristics of mixtures;• learn to recognize the signs that characterize chemical reactions;• apply their knowledge to a specific lab activity and an analysis of available employment opportunities in their community newspaper.

Activity/ Time	Learning Expectations	Assessment and Evaluation Categories, Tasks, and Tools	Tasks
3.3 Rates of Chemical and Physical Processes 9 hours	CIMV.01, .02, CIM1.04, 2.04, 2.05 SIMV.02, .03, SIM2.01, 2.03, 2.04, 3.01, 3.03 CGE3c	3.3.3: Lab technique is assessed for Inquiry using a checklist. 3.3.4: The oral presentation is evaluated for Communication and Making Connections using a rubric.	Students perform laboratory investigations to: <ul style="list-style-type: none"> • identify the factors that affect the rate of dissolving; • explore the claim: “Brand X antacid provides relief faster than other brands and is the best antacid available,” by determining which antacid dissolves the fastest; • identify the factors that affect the rate of chemical reactions; • determine which antacid neutralizes the fastest; • present their opinion, based on their investigation.
3.4 Experimental and Media- Based Research 3 hours	CIMV.03, CIM3.01, 3.02, 3.03 SIMV.03, SIM3.01, 3.02 CGE2b, 2e, 3c, 3f, 4f, 5a	3.4.1: The skills used throughout the investigation will be assessed for Inquiry using a checklist. 3.4.2: The list of advantages and disadvantages of both the natural and synthetic products will be evaluated for Knowledge/Understanding and Communication using a rubric. 3.4.4: The opinion piece will be evaluated for Communication and Making Connections using criteria with marking scheme.	Students: <ul style="list-style-type: none"> • plan and conduct an investigation to determine the advantages and disadvantages of using natural versus synthetic products; • perform media-based research to further their understanding of using natural versus synthetic products; • analyse the costs and benefits of using natural versus synthetic products; • state an opinion on whether they believe that natural or synthetic products should be used.

Activity 3.1: Identifying and Understanding Chemicals Found in the Home and Workplace

Time: 5 hours

Description

Students are introduced to common chemicals found in their everyday lives through the thorough investigation of labels. Students look at the chemicals found in a product, identify hazardous symbols, and question the claims that are often made in selling a product. Students realize that more information can be obtained in regards to hazardous products, using MSD sheets. Students are made aware that MSD sheets can be found in any workplace where these types of products are used. Students complete the activity by demonstrating their knowledge of labels through the creation of their own label for a given product.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE2b - reads, understands and uses written materials effectively;

CGE2c - presents information and ideas clearly and honestly and with sensitivity to others;

CGE2d - writes and speaks fluently one or both of Canada's official languages;

CGE2e - uses and integrates the Catholic faith tradition, in the critical analysis of the arts, media, technology and information systems to enhance the quality of life.

Strand(s): Scientific Inquiry: Science in Media; Chemistry: Interaction of Common Materials

Overall Expectations

CIMV.01 - understand how chemicals in common household and workplace materials interact;

CIMV.02 - investigate the types and rates of interactions between commonly used materials through laboratory activities;

SIMV.01 - explain how science-related information is presented in print and electronic media for different purposes and audiences;

SIMV.02 - investigate science-related information presented in print and electronic media, using appropriate research and reporting skills;

SIMV.03 - evaluate claims and presentations of science-related information in media.

Specific Expectations

CIM1.01 - recognize the relationships among chemical formulae, composition, and common names;

CIM1.02 - classify chemicals into groups according to their behaviour, using appropriate scientific terminology;

CIM2.01 - select and use appropriate lab equipment and apply WHMIS safety procedures for the handling, storage, disposal, and recycling of laboratory materials;

CIM2.05 - communicate the results of investigations using a variety of oral, written, and graphic formats;

SIM1.01 - identify the ways in which scientific information is conveyed;

SIM1.03 - explain how different formats used in the media to present science information target specific audiences;

SIM2.03 - interpret research data, including analysis for accuracy and bias as appropriate, using a range of strategies for reading for information;

SIM3.04 - communicate science-related information to a workplace audience by creating a media work.

Prior Knowledge & Skills

- Understanding of literacy skills, e.g., reading for information, reading for inference

Planning Notes

3.1.1 Let's Look at Labels!

- Select and provide students with samples of products from the home and workplace, e.g., cleaners, antacids, hair products.
- Prepare a reference list of hazardous symbols.

3.1.2 Beyond Labels to MSD Sheets

- Obtain MSD sheets ahead of time. Teachers may choose to give students a common sheet or several different copies.

3.1.3 Classification of Chemicals

- The choice of products for investigation should include a wide variety of products such as acids, bases, oxidizers, flammables, etc.

3.1.4 Making Labels

- Several media pieces should be prepared/collected ahead of time to discuss claims made by given products.

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- Information and materials for labels created as a class and for the individual student assignment should be prepared ahead of time.

Teaching/Learning Strategies

3.1.1 Let's Look at Labels!

- The teacher provides students with a series of products from the home and the workplace, e.g., cleaners, antacids, hair products, food, to allow students to identify the names of chemicals found in these products.
- Students draw up a list of these products and organize them in a chart. The headings found on the chart could include: Product Name, Use, Chemicals and/or Formulas Found Within, Hazardous Symbols.
- As a suggested homework assignment, students add two items found in their home or a grocery store to their lists.
- Students identify the hazardous symbols found on the labels and record them to be able to recognize them for future use. They use their reference list to confirm the accuracy of their symbols.

3.1.2 Beyond Labels to MSD Sheets

- Students are led, through discussion, to an understanding of the different types of hazardous materials. They are given a range of MSD sheets to interpret the information found on labels and make wise choices. Students identify and discuss with the aid of the teacher:
 - Hazard rating for Health, Flammability, and Reactivity
 - Dangerous ingredient
 - Fire and Explosion Hazard data
 - Reactivity data
 - Toxicological properties
 - Preventive measures
- Following these lessons, students write the online test for WHMIS for a licence to include in their portfolio (refer to Resources).

3.1.3 Classification of Chemicals

- The teacher performs, through demonstrations, 'identifying' tests, using the products that were previously listed, to identify types of chemicals present, e.g., indicators to identify an acid or a base. The teacher models the safety presentations with students assisting, where appropriate.
- Based on the information learned in the charting of the found chemicals in activity 3.1.1, the guided tour of the MSD sheets in 3.1.2, and the teacher demonstrations, students classify their list of chemicals according to behaviour and hazards, e.g., oxidizer, flammable, explosives, acids, bases. Students demonstrate this through a graphic organizer, chart, or other method of their choice.

3.1.4 Making Labels

- Using a variety of media pieces, the teacher leads a class discussion about media claims. The teacher reminds students of their experience analysing media claims in Unit 1: Inquiry: Science in Media, e.g., how the claim is useful, the validity of the claim, understanding why it is necessary to have a claim on a product). The teacher should include claims that have a scientific basis, e.g., pH balanced, fat-free.
- Students work together as a class to create a label for a given product based on information provided by the teacher, e.g., chemicals found within, behaviour of product, cautions and hazards.
- Individually, students make a label for a given product using information provided by the teacher. Students must include a claim with their label. The format of this assignment could be a poster, a flyer, or an actual label pasted on a used container.

Assessment & Evaluation of Student Achievement

See *Assessment & Evaluation of Student Achievement in Overview*, p. 8.

- In activity 3.1.3, the information organized in a chart is assessed for Knowledge/Understanding and Communication using a checklist.
- In activity 3.1.4, the label done individually by students is evaluated for Inquiry, Making Connections and Communication, using a rubric.

Resources

Science Resources

Print

Science Teachers of Ontario. *Stay Safe*. Toronto: STAO, 2002. ISBN 1-894592-01-8

Websites

American Chemical Society – www.chemistry.org

Bill Nye the Science Guy – www.nyelabs.com

Discovery.com – <http://www.discovery.com>

Madsci Network – <http://www.madsci.org/experiments>

Software

Smart Ideas. Ministry-licenced OSAPAC — Graphic Organizers

Workplace Link Resources

Websites

Live Safe Work Smart – www.livesafeworksmart.net

TOWES (Test of Workplace Essential Skills) Project – www.towes.com

Activity 3.2: Physical Processes and Chemical Reactions

Time: 9 hours

Description

Students learn some common terms associated with the physical and chemical properties of matter. They address specific characteristics of mixtures and the separation of mixtures through a variety of physical processes, e.g., flotation, sedimentation, filtration, distillation. Students learn to recognize characteristics of chemical reactions and perform a series of chemical reactions which include decomposition, displacement, and neutralization. Students participate in a laboratory activity, use media-based information, and differentiate between physical processes and chemical reactions inherent in the lab component and implied in the media piece. Students review lab safety and the terminology used to describe matter before examining the properties of mixtures and the physical processes involved in separating mixtures. They study chemical properties and chemical reactions to enable them to distinguish between physical interactions and chemical reactions. The emphasis is on learning by doing, through hands-on experiences. The teacher links these tasks to household and/or workplace materials, and real-world examples are discussed or researched.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE5d - finds meaning, dignity, fulfillment and vocation in work which contributes to the common good;

CGE7i - respects the environment and uses resources wisely.

Strand(s): Scientific Inquiry: Science in Media; Chemistry: Interaction of Common Materials

Overall Expectations

CIMV.01 - understand how chemicals in common household and workplace materials interact;
CIMV.02 - investigate the types and rates of interactions between commonly used materials through laboratory activities;
CIMV.03 - analyse how material interactions affect our daily lives;
SIMV.02 - investigate science-related information presented in print and electronic media, using appropriate research and reporting skills.

Specific Expectations

CIM1.03 - distinguish between chemical reactions and physical processes, using appropriate scientific terminology;
CIM2.01 - select and use appropriate apparatus and apply WHMIS safety procedures for the handling, storage, disposal, and recycling of laboratory materials;
CIM2.02 - conduct experiments to investigate how materials can interact chemically;
CIM2.03 - conduct experiments to investigate how materials can interact physically;
CIM3.01 - research the behaviour of materials that are used in daily life;
SIM2.02 - research science-related information from a variety of electronic and other sources;
SIM2.04 - organize and communicate information collected from lab investigations and information research, using graphic organizers.

Prior Knowledge & Skills

- Acquisition of operator licences for using various laboratory equipment, safety, lab skills, research, organization

Planning Notes

- Before doing any laboratory work the teacher reviews MSD sheets and laboratory procedures to become familiar with potential safety concerns and to alert students to specific safety concerns before they conduct their investigations.
- If available, the teacher may choose to show a video on safety procedures (see Resources).
- A number of tasks involve moving from one station to another. Have specific safety reminders at each station, where a problem may exist. The reminder may take the form of a large print warning posted alongside the station number or may be included as part of a prepared laboratory activity sheet.
- Each laboratory activity involves some degree of cleanup. Make clear the expectations for cleanup of the work area and the proper disposal of materials.

3.2.1 Welcome to the Chemistry Lab: Let's Review

- Group students into expert/novice pairs for tasks 1 and 3. Since this activity reviews some material encountered in the LDCC Grade 9 Science course, each group should have one student who is familiar with the terms associated with physical and chemical properties of matter.
- Prepare handouts of the classroom floor plan. The handout should leave space for a student legend and student responses to questions.
- Post two or three copies of a simplified version of How to Use This Fire Extinguisher next to each fire extinguisher.

3.2.2 Physical Processes

- Collect the materials needed to set up a variety of stations and a vocabulary-matching list to review/introduce terms/actions used to describe materials in the LDCC Grade 9 Science course. See Appendix 3.2.1: Chemical and Physical Properties (Possible Stations) for suggested stations and student handout.

- Review the suggestions made in the teaching/learning strategies and consider alternative methods of delivering the content without sacrificing the student's hands-on experiences. For example, equipment for distillation may be an issue in some schools, which means that a demonstration might be appropriate or that creative alternatives to a Leibig condenser be used. Alternative methods of delivering the program could involve the use of student demonstrations.
- Obtain samples of oil (vegetable, canola, etc), copper(II) sulfate crystals, calcium carbonate powder, and soil.
- Set aside equipment: scoopulas, graduated cylinders, test tubes, stoppers, 250 mL beakers, 100 mL beakers, funnels, filter paper and hot plates.
- Provide a handout which has appropriate laboratory procedures for separating mixtures.
- Locate articles and/or reading passages from textbooks and prepare questions on the following topics: filtration, sedimentation, flotation, distillation, waste water treatment.

3.2.3 Chemical Reactions

- Locate and have available materials and equipment to set up stations and conduct demonstrations. See Appendix 3.2.2: Characteristics of Chemical Reactions for examples of chemical reactions that could be possible stations to include in a student handout.
- Create lab activity handouts for those chemical reactions that will be performed by the students (decomposition, neutralization, displacement, precipitation).
- Prepare review-type exercises on chemical vs. physical change, and the classification of chemical reactions based on laboratory observations.
- Locate articles and/or a reading passage from a text on fuel cells.

3.2.4 Differentiating Between Chemical Reactions and Physical Processes

- Locate or create a group of ads typical of those that would be found in the Employment section of the local newspaper. See Appendix 3.2.3: Sample Want Ad for a sample simulation of such an ad, and create a handout for each student.
- See Appendix 3.2.4: Slime Time for one variation of a 'slime' recipe.

Teaching/Learning Strategies

3.2.1 Welcome to the Chemistry Lab: Let's Review

- Students work in pairs.
- The teacher provides each student with a classroom floor plan.
- Pairs move around the classroom to locate and note on the floor plan the location(s) of the exits, fire extinguisher(s), fire blanket, broken glass disposal bucket, sand bucket, first aid kit, eyewash station, etc.
- With the assistance of posted directions and the teacher acting as a resource, the students answer a series of questions such as:
 - What is the fire exit route from the classroom?
 - How do I use the fire extinguisher?
 - Can this extinguisher be used on all types of fires? Why? Why not?
 - What do I do if I or my lab partner is cut or caught on fire?
 - How does the eye wash work?
- After a reasonable amount of time the teacher addresses any unanswered questions through a class discussion.
- Students remove their list of laboratory safety rules from the portfolio and observe a demonstration of a laboratory procedure conducted by the teacher.

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- Students place a check mark next to the safety rules followed by the teacher and submit the list at the end of the demonstration for evaluation.
 - The teacher sets up a number of stations to provide a concrete activity in which the expert/novice student pairs review or are introduced to the terms used to describe the physical properties (lustre, clarity, malleability, change points, magnetic, odour) and chemical properties (neutralizer, corrosive) of various commonly found materials.
 - The teacher (assisted by student partners) concludes the task by providing some ‘identifying’ tests for various substances: acid, base, carbon dioxide, oxygen, hydrogen.

3.2.2 Physical Processes

- Students work in pairs to make four different mixtures. A sample procedure could be: Students pour water into each test tube and add a small sample of a material provided by the teacher. The test tube is stoppered and shaken. Observations are recorded in a predesigned observation chart in their notebook. The student repeats the process three times. These mixtures are set aside for later use.
- As a class, students discuss the physical characteristics of each mixture. The students and teacher discuss the terms used to describe mixtures (suspension, emulsion, solute, solvent, solution) and make a list of examples found in everyday situations on the board. Students apply the definitions to classify their mixtures.
- The teacher introduces separation methods (sedimentation, flotation, filtration) used in industry and explains how each separation method can be carried out in a laboratory situation.
- Students carry out a laboratory procedure to test the effectiveness of each separation technique on their mixtures.
- The teacher rotates through the class, ensuring safety, and assisting with laboratory techniques, e.g., folding filter paper to fit into a funnel.
- Students record their observations and conclusions. They should realize that the copper(II) sulfate solution could not be separated by any of the methods.
- Students, in pairs, discuss the characteristics of the copper(II) sulfate solution which make it unsuitable to be separated by the three methods introduced earlier. They brainstorm potential methods to separate both substances in this mixture. The brainstorming leads to a setup for the distillation of the solution. Ideally, the actual distillation could be carried out by each pair of students, e.g., using an evaporating dish on a hot plate, or demonstrated using distillation equipment by the teacher.
- The teacher discusses decision-making models, and explains how an algorithm (a flow-chart showing a logical sequence of steps) can be used to determine a course of action, e.g., in health care, auto repair, troubleshooting appliances. Using the information from their observation chart, students create an algorithm useful for determining the best method of separating future mixtures.
- The teacher and students discuss everyday examples of separating mixtures. Students are given a reading describing industrial applications of physical separation, e.g., distillation in winemaking, wastewater treatment, recycling plants, and highlight the important steps and explain the importance of the key steps in the process.
- The teacher and students discuss student answers, focusing on the effects of chemicals on the environment.

3.2.3 Chemical Reactions

- Students work in pairs and rotate through a series of activities designed to demonstrate the indicators of a chemical reaction (heat in/out, colour change, appearance of a new substance such as a powder or gel, evolution of a gas). See Appendix 3.2.2: Characteristics of Chemical Reactions. Students will need new vocabulary to describe these properties, e.g., pungent, acrid, aromatic. Safe lab technique should be emphasized and demonstrated where necessary, e.g., ‘wafting’ technique for smelling chemicals.
- The teacher moves through the class ensuring safety and proper disposal of materials.

- As a class, students discuss and record the indicators of a chemical reaction.
- The teacher provides students with a handout to practise distinguishing between physical and chemical changes.
- The teacher introduces reaction types by demonstrating common chemical reactions, e.g., combustion of magnesium (**Note:** This activity should be done in a fume hood, as the products are toxic), synthesis of zinc sulfide, decomposition of hydrogen peroxide, electrolysis of water, glycerol and potassium permanganate, silver nitrate and sodium chloride, aluminum and copper(II) sulfate, reaction of sodium hydroxide and hydrochloric acid.
- For each demonstration, students discuss the indicators of chemical change, and with teacher assistance, relate the reaction with common industrial reactions, e.g., combustion of magnesium = combustion of fuels, decomposition of hydrogen peroxide = decomposition of sodium chloride to produce chlorine gas, reaction of aluminum and copper(II) sulfate = precipitation of metal ions in waste water.
- The teacher provides an article on relevant industrial reactions discussed previously, e.g., fuel cells, waste water treatment, corrosion, oxidation/reduction in batteries.
- Students summarize the important points in the reading and discuss it as a class.
- Students add the article summary to their portfolio for use in Unit 5: Community Action Plan.
- Students complete a handout requiring them to match the characteristics of reactions observed in class with the characteristics of common industrial reactions.
- The teacher and class discuss the exercise answers.

3.2.4 Differentiating Between Chemical Reactions and Physical Processes

- The teacher provides each student with want ads from the Employment section of a local newspaper (refer to Appendix 3.2.3: Sample Want Ad) and discusses jobs requiring an understanding of physical and chemical properties and reactions. The teacher and students also discuss the value of finding jobs that are fulfilling, and the reward in finding jobs that contribute to the greater good.
- Students are asked to select four want ads for employment in which knowledge of a physical process or a chemical reaction would be required.
- Students identify the jobs, explain their selections, and submit their work.
- The teacher provides each student with a set of instructions for making slime (see Resources and Appendix 3.2.4: Slime Time).
- Each student works independently and follows the directions provided by the teacher.
- Each student writes an observation beside each step where an interaction of materials occurs, states whether that interaction is physical or chemical, and justifies his/her choice.
- Students identify a practical use for this product, based on its chemical and physical properties. Students perform simple tests on this material to identify its chemical and physical properties, e.g., reactivity with water/acid, density, malleability, solubility in alcohol.
- Students complete a patent application worksheet (Refer to Appendix 3.2.5: Patent Application) and submit it for evaluation.

Assessment & Evaluation of Student Achievement

See Assessment & Evaluation of Student Achievement in Overview, p. 8.

- In activity 3.2.1, safety rules are evaluated for Knowledge/Understanding using a checklist.
- In activity 3.2.2, the algorithm is evaluated for Communication and Making Connections using a rubric.
- In activity 3.2.4, the selection and analysis of want ads and the patent application are evaluated for Making Connections using a checklist.

Resources

Science Resources

Print

Margoli, M. *ABCs of Chemistry Hands-on Science Series*. Walch, 2000. ISBN 0-8251-3931-7

Websites

Idea Place – <http://ideaplace.org/Sci9/Sci9Labs/CleanCopy.cgi?lf=Slime>

Kids Domain – <http://www.kidsdomain.com/craft/silly.html>

MadSci Network – <http://www.madsci.org/experiments/>

Rubric Tool Network – <http://www.uen.org/rubric/>

Slime Recipe – <http://www.uwm.edu/~tholme/fun/srec.html>

Workplace Link Resources

Websites

TOWES (Test of Workplace Essential Skills) Project – www.towes.com

Resources for Catholic Teachers

Websites

Eastern Ontario Catholic Curriculum Cooperative – <http://www.eoccc.org>

Faith and the Common Good – <http://www.faith-commongood.net>

Appendix 3.2.1: Chemical and Physical Properties (Possible Stations)

Station	Example of task	Observation	Is this a physical or chemical property?
1	Clarity: Match the material with each of the terms.	transparent translucent opaque	
2	Density: Pour 5 mL of water into a test tube and add 1 mL of oil, 1 small pebble, 1 pea. Draw what you see, then discard the mixture into the container provided.	<i>sketch</i>	
3	Magnetism: Test a piece of sulfur, a piece of aluminum, and a piece of iron with a magnet.		
4	Evaporating Points: Soak one strip of filter paper in water and one in isopropyl alcohol. Put both strips on a warm 'hot plate.' Observe, then discard strips in containers.		
5	Heat a nichrome wire in a Bunsen burner flame.		
6	Dip a nichrome wire into a solution of LiNO_3 . Test in Bunsen burner flame.		
7	Odour: Open the bottles one at a time and match the odour with an adjective. Do not leave the bottles open, and use proper 'wafting' technique for smelling chemicals.	pungent acid aromatic	
8	Malleability: Check how easy it is to bend the metal samples (lead, copper, aluminum, tin, etc.).		
9	Put a drop of iodine on a piece of paper, a piece of bread, and a piece of potato. Discard as directed.		
10	Solubility: Pour 5 mL of water in one test tube and 5 mL of alcohol into another. To each add a small scoop of sugar. Shake well and observe. Discard as directed.		

Appendix 3.2.2: Characteristics of Chemical Reactions

Station	Examples of tasks	Student Observation
1	(MgSO ₄ · 7H ₂ O _(s)) Epsom salts + CaCl _{2(aq)} (an ice melting salt solution)	white solid
2	NH ₄ Cl _(s) + water	temperature decrease
3	Grape juice + mild NaOH _(aq) (drain cleaner)	colour change: to green
4	Use small (personal) straw and blow into test tube containing 2-3 mL limewater	cloudy
5	Repeat above using bromothymol blue solution	yellow
6	Phenolphthalein + NaOH _(aq) (a drain cleaner)	colour change: pink
7	Antacid tablet + 0.1M HCl _(aq)	gas produced
8	CuSO _{4(aq)} + NaOH _(aq)	blue gel
9	KSCN _(aq) + Fe(NO ₃) _{3(aq)}	blood red colour
10	Metal piece (e.g., Zn) + acid	gas produced/temperature increase
11	Marble chip + acetic acid (vinegar)	Gas
12	Drop of bleach on piece of black paper or cloth	colour change

Appendix 3.2.3: Sample Want Ad

Oh So Green! – An award winning landscaping company seeks full-time and part-time people to work in its greenhouses. WHMIS training provided, as job will require handling of fertilizers, pesticides, fuels, solvents, and other chemicals. A competitive rate of pay and a flexible work schedule is offered. Students are welcome to apply. Applications taken at the Tulip Lane Greenhouse starting Monday, February 1.

Appendix 3.2.4: Slime Time

In this activity you will make some slime. As you follow the directions, observe what is happening and note at each step whether the changes taking place are physical interactions or chemical reactions.

Materials needed: water, white glue (containing polyvinyl alcohol), Borax® (sodium hydrogen borate), food colouring (optional).

Equipment needed: wooden sticks/stir sticks, graduated cylinders, disposable cups

Procedure:

1. Pour 10 mL of glue (white) into a disposable cup, and mix in 10 mL of water.
2. Add 10 mL (2 teaspoons) of sodium hydrogen borate to a second disposable cup, and add just enough water to dissolve the solid.
3. Slowly add some of the Borax solution to the glue. Stir. Keep repeating this step until you get the desired slimy consistency.

Appendix 3.2.5: Patent Application

Patent Application		Date:
Name of Product		
Diagram of Product as it will be used (including labels)		
Abstract (summary of Product Use)		
Description of Physical and Chemical Properties of Product		
What makes your product unique?		

Activity 3.3: Rates of Chemical and Physical Processes

Time: 9 hours

Description

Through laboratory investigations, students identify the factors that alter the rate of dissolving, including temperature, agitation, and size of particles. Presented with a media claim, e.g., “Brand X is the best antacid,” students plan and conduct laboratory investigations based on the concept of a ‘fair test’ to assess this claim. Students investigate which antacid dissolves the fastest in simulated stomach acid and use the observations and information from the packages or labels to complete a plus/minus analysis. The Master Form Licence is used as a guide for their plus/minus analysis that was obtained in Unit 1: Scientific Inquiry: Science in Media. Students study rates of chemical reactions and perform laboratory investigations to identify the effects of temperature, concentration, surface area, and the presence of a catalyst on the rate of a chemical reaction. The ‘claim’ is further explored as students investigate the rates of neutralization of the antacids and add their results to their ‘plus/minus analysis.’ Students assess the ‘claim’ and communicate their opinion about whether Brand X is the best antacid. The peer, self-, and teacher feedback received increases the students’ opportunity for success in Activity 3.4.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE 3c - thinks reflectively and creatively to evaluate situations and solve problems.

Strand(s): Scientific Inquiry: Science in Media; Chemistry: Interactions of Common Materials

Overall Expectations

CIMV.01 - understand how chemicals in common household and workplace materials interact;

CIMV.02 - investigate the types and rates of interactions between commonly used materials through laboratory activities;

SIMV.02 - investigate science-related information presented in print and electronic media, using appropriate research and reporting skills;

SIMV.03 - evaluate claims and presentations of science-related information in media.

Specific Expectations

CIM1.04 - identify the factors that alter the rate of physical processes and chemical reactions;

CIM2.04 - conduct experiments to determine the factors affecting rates of chemical reactions and physical processes;

CIM2.05 - communicate the results of investigations using a variety of oral, written, and graphic formats;

SIM2.01 - formulate testable questions and carry out investigations on science-related claims based on the concept of a fair test;

SIM2.03 - interpret research data, including analysis for accuracy and bias as appropriate, using a range of strategies for reading for information;

SIM2.04 - organize and communicate information collected from lab investigations and information research using graphic organizers;

SIM3.01 - formulate testable questions about science-related claims and representations in the media;

SIM3.03 - evaluate the investigation and suggest improvements.

Prior Knowledge & Skills

- An understanding of how to create a plus/minus analysis
- Acquisition of operator licences for using various laboratory equipment, safety, and lab skills from Activity 3.2
- Ability to formulate testable questions, organize information collected from lab investigations, and develop procedures
- Use of computers

Planning Notes

- Collect and prepare media examples of advertisements of antacids needed for activity 3.3.2. Examples used in unit 1 Inquiry: Science in Media could also be suitable or students could bring in samples.
- Prepare the various licences needed for this activity including the Chemistry Terminology (introduced earlier in this Unit), using equipment (timer or stopwatch), and review the Master Form and any laboratory skills licences, e.g., safety.

3.3.1 Rates of the Physical Processes of Dissolving

- **Note:** The investigations listed are for the dissolving process only. If time permits, the following other physical processes could also be measured or demonstrated:
 - a) the rates at which various solutions reach their boiling point or freezing point using different concentrations of antifreeze solutions or salt solutions;
 - b) the rates of water/perfume evaporation, using different surface areas, amounts, or temperatures.
- All templates (lab instructions, assessment tools, etc.) should be prepared ahead of time.
- A variety of antacids should be purchased ahead of time, including brand name and generic examples. Detergents or shampoos can be substituted for the antacids.
- The antacid investigation is designed to reinforce material and skills from Unit 1 Inquiry: Science in Media and to provide practice and the necessary feedback to allow for increased success in the final activity in this unit. If time is a factor, then the antacid investigation can be condensed to one investigation, e.g., the rate of dissolving or the rate of neutralization or both can be completed during the same period.
- Substitute pH probes with computer software or pH meters for the indicator in activity 3.3.4, if they are available, to give students additional practice using this technology. Interactive laboratory websites are another option depending on time, class, and student needs.

3.3.3 Rates of Chemical Reactions

- Set up the lab stations beforehand with clear instruction available at each station area. Large beakers should be available to collect all chemical waste and marks could be allotted in the lab technique evaluation for cleanup and proper disposal of waste.
As in activity 3.3.2, depending on the needs of the students, the procedures can vary or one procedure could be determined by the class that all students perform. A simplified procedure appears in Appendix 3.3.2.

3.3.4 Which Antacid Neutralizes the Fastest?

- Prepare copies of the Essential Skills profiles (see Resources) for one or more careers, e.g., pharmacy assistant or grocery store clerk, ahead of time.

Teaching/Learning Strategies

3.3.1 Rates of the Physical Processes of Dissolving

- Students participate in a teacher-guided discussion pertaining to rates of reactions and obtain the Chemistry terminology licence, e.g., dissolving, solutions, solute, solvent, concentration, surface area, etc., for this activity to be placed in their portfolio.
- Students review the Master Form example in their portfolio, practise using a stopwatch accurately, and add this skill to their lab skills licence. The teacher introduces students to the assessment tools for this activity.
- The teacher clearly outlines the tasks and students carefully and safely follow instructions to determine the effect of the following factors on the rate of dissolving:
 - a) particle size (students measure the time for a sugar cube to dissolve in 100 mL of water compared to a teaspoon of granular sugar in 100 mL of water)

-
- b) temperature (students measure the time for a teaspoon of sugar/salt to dissolve in 100 mL of cold water, in 100 mL of room temperature water, and 100 mL of hot water)
 - c) agitation (students measure the time for a sugar cube to dissolve in 100 mL of water without stirring, and then repeat with stirring)

This activity could also be set up at stations depending on the needs of the students, time, and classroom.

- Students gather data in the form of a chart, and guided by the teacher, they summarize how each factor alters the rate of dissolving.

3.3.2 Which Antacid Dissolves the Fastest?

- Students study various media examples provided by the teacher advertising different antacids. The teacher reminds students to think reflectively and to evaluate all the different claims. Students brainstorm to formulate testable questions that allow them to develop a plan to test the advertised claim that Brand X antacid is the fastest relieving and the best antacid, e.g., How much does the antacid cost? How fast does it work? How much acid will it neutralize?
- Guided by the teacher, students select How fast does it work? as the testable question. The teacher provides the list of materials for the investigation and students develop a procedure, including any safety concerns, to measure the time for antacids to dissolve in simulated stomach juices (0.1 M hydrochloric acid or 1 part vinegar: 2 parts water mixture). Depending on the needs of the students, the procedures can vary or one procedure could be determined by the class that all students perform. The teacher approves all individual procedures and students carefully perform the investigation. In a sample procedure students add one dose of the antacid to a sealed (zipper-locked) plastic bag (to simulate the stomach) containing 5 mL of vinegar and 10 mL of water, and they measure the time for the tablet to dissolve completely. (If time is a factor each student can test one antacid).
- The students use their data (the rate of dissolving) and any other information collected from the packages or labels, e.g., ingredients, price of the antacids to prepare a plus/minus analysis using a graphic organizer.
- In pairs, students peer assess their analysis and use the feedback to make any changes to improve their plus/minus analysis.

3.3.3 Rates of Chemical Reactions

- The teacher reviews the factors that alter the rates of physical processes and expands the concepts to rates of chemical reactions. The teacher introduces the lab activity by guiding students through each of the individual laboratory stations set up to investigate the effect of concentration, surface area, temperature, and catalyst. Students review the instructions, including safety precautions, posted at each station. Refer to Appendix 3.3.1: Rates of Chemical Reactions: Sample Instructions for Station 1 for Activity 3.3.3.
 - Students use the information at the stations to prepare the four observations charts (Concentration, Surface Area, Temperature, and Catalyst) needed. Students study the safety concerns noted at each station. The teacher introduces students to the assessment tools for this activity.
 - Students carefully follow instructions and rotate through each of the four following stations set up to investigate the effects of concentration (Station 1), Surface Area (Station 2), Temperature (Station 3) and Catalyst (Station 4) on the rate of a chemical reaction.
 1. Station 1 consists of three small beakers with 10 mL of various concentrations of dilute acid (1M, 0.1M, 0.01M HCl) or vinegar and three equal pieces of chalk (approx. 2 cm). Students carefully add the chalk to each of the test tubes and record the reaction (degree or amount of bubbles or measure the time it takes for the bubbles to cease);

-
2. Station 2 consists of two small beakers containing 10 mL of 0.1M HCl, two pieces of 2 cm-length chalk, a timer, and a mortar and pestle. Students add the 2 cm-length piece of chalk and record the time of the first reaction. The students crush the other piece of chalk, carefully add it to the last beaker, and measure and record the time of the reaction (bubbles cease);
 3. Station 3 consists of three beakers of water at different temperatures (cold, room temperature, and warm), three equal pieces of an effervescent tablet, and a stopwatch or timing device. Students carefully place one of the tablets in the cold water and measure and record the time for the reaction to cease. They repeat this process with the room temperature water and then the warm water;
 4. Station 4 consists of four test tubes. Test tube A contains 10 mL 3% hydrogen peroxide, test tube B contains 10 mL 3% hydrogen peroxide and a small piece of potato, test tube C contains 10 mL 3% hydrogen peroxide and a small piece of liver, and test tube 4 contains 10 mL 3% hydrogen peroxide and a small amount of manganese dioxide. Each test tube should be prepared separately, and the rate of bubbling can be observed.
- Students participate in a teacher-led discussion summarizing the factors that alter the rates of chemical reactions and submit their observation charts to be evaluated.

3.3.4 Which Antacid Neutralizes the Fastest?

- Students review their Chemistry Terminology Licence in their portfolio on acid/base terms, including neutralization, pH, and the role of an indicator as well as their plus/minus analysis.
- Directed by the teacher and using the plan from activity 3.3.2 as a guide, students outline a procedure (including materials, observation chart, and any safety concerns) to test the question, Which antacid neutralizes the fastest? Refer to Appendix 3.3.2: Sample Procedure. Students add the results of which antacid neutralized the fastest to complete their plus/minus analysis. Students record their observations in the plus/minus chart. They review all of the information in their analysis to formulate an opinion as to which antacid they would recommend as the fastest relieving and the best antacid.
- Taking on the role of a store employee in a pharmacy, the students use their opinion to make a recommendation (oral) to a customer looking at a shelf filled with antacids and wondering which one to buy.
- The teacher provides examples of Essential Skills Profiles for one or more workplace position, e.g., a pharmacy assistant, store clerk, and students, working in groups of three, become familiar with the most important Essential Skills needed for these positions. One member of each group shares orally with the class at least one 'aha' e.g., something in the profile that surprised the group.

Assessment & Evaluation of Student Achievement

See *Assessment & Evaluation of Student Achievement in Overview*, p. 8.

- In activity 3.3.3, lab technique is assessed for Inquiry using a checklist
- In activity 3.3.4, the oral presentation is evaluated for Communication and Making Connections using a rubric.

Resources

Science Resources

Print

Heikkinen, H. *Chemistry in the Community: Chem Com*. 4th ed. American Chemical Society. New York: W. H. Freeman and Company, 2002. ISBN 0-7167-3551-2

Margoli, M. *ABCs of Chemistry*. (Hands-on Science Series) J. Weston Walch, 2000. ISBN 0-8251-3931-7

Newton, D. *Chemistry*. (Walch Science Literacy Series) Maine: J. Weston Walch, 1997. ISBN 0-8251-3311-4

Science Teachers of Ontario. *Stay Safe*. Toronto: STAO, 2002. ISBN 1-894592-22-0

Sci-Tech Ontario. *Real Science: Using projects to engage students and meet the goals of the Ontario Curriculum, Grades 9 to 12*. 1st edition. Ontario: Sci-Tech Ontario, 2003.

Websites

Cleaner and Greener: An Energy and Environment Program – www.cleanerandgreener.org

Community Learning Network – www.cln.org

David Suzuki Foundation – www.davidsuzuki.org

Discovery.com – <http://www.discovery.com>

Pasco Chemistry Antacid Experiment – www.pasco.com/experiments/chemistry/april_2002/home

Rate Lab – www.sciencehouse.org/learn/CountertopChem/exp14

Science Lessons – www.chem4kids.com

Workplace Link Resources

Websites

Essential Skills – www.hrdc-drhc.gc.ca

Live Safe Work Smart – www.livesafeworksmart.org

TOWES (Test of Workplace Essential Skills) Project – www.towes.com

Software

Chemistry with Computers Using Logger Pro. CD-ROM. Vernier Software, 2000.

Smart Ideas. Ministry-licensed OSAPAC – Graphic organizers

TABS Plus. – Computer program that designs and prints out nets (blueprints) to design and build three-dimensional shapes of your choice.

Resources for Catholic Teachers

CD-ROMs

Curriculum Support for Catholic Schools. Eastern Ontario Catholic Curriculum Cooperative, 2002.

Appendix 3.3.1: Rates of Chemical Reactions: Sample Instructions for Station 1 for Activity 3.3.3

Materials: Safety Goggles	Apron	Waste beaker
Acid A	Acid B	Acid C
Chalk	3 beakers	Stopwatch

Procedure: Safety Goggles and Aprons must be worn at all times.

1. Place a piece of chalk of equal size into each beaker.
2. Add Acid A carefully to the red line (10 mL) of the first beaker.
3. Start the stopwatch.
4. Stop the stopwatch when the reaction is over and record the time in your chart.
5. Repeat with Acid B in the next beaker.
6. Repeat with Acid C in the last beaker.
7. Pour the contents of each beaker into the beaker marked waste.
8. Clean up your station.
9. Did you remember to:
 - a) Wash the beakers?
 - b) Wash the counter space?
 - c) Wash your hands?

Appendix 3.3.2

Part A: Sample Procedure

- Students measure and compare the time for antacids to change the pH of simulated stomach juices (0.1 M hydrochloric acid or 1 part vinegar: 2 parts water mixture) to a pH=7.
- Students add one dose of the antacid to a sealed (zipper-locked) plastic bag containing 5 mL of vinegar and 10mL of water and an indicator such as Universal Indicator and record the time for the indicator to change colour.

Part B: Sample Data for Activity 3.3.2 and 3.3.4

Name of antacid	Brand X	Brand Y	Brand Z
Price/Cost	\$.02 per tablet		
Number of tablets per dose	1-2 tablets		
Strength	Ultra		
Active Ingredient	Calcium carbonate		
Cautions/Warnings	Keep out of reach of children. Do not take within 2 hours of another medicine.		
Other	Sugar was an ingredient Good source of calcium		
Flavour	Assorted fruit		
Time to dissolve	2 minutes		
Time to neutralize or change in pH	pH changed from 3 to 5 in 10 minutes		

Activity 3.4: Experimental and Media-Based Research

Time: 3 hours

Description

Students demonstrate most of the skills learned throughout previous activities in this unit. They use skills of problem solving, media-based research, and investigation to determine the advantages and disadvantages of using a natural product versus a synthetic product. In order to prepare for Unit 5: Community Action Plan, students analyse the costs and benefits of natural versus synthetic products, and using prior skills, they write an opinion piece based on the evidence presented in the activity.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE2b - reads, understands and uses written materials effectively;

CGE2e - uses and integrates the Catholic faith tradition, in the critical analysis of the arts, media, technology and information systems to enhance the quality of life;

CGE3c - thinks reflectively and creatively to evaluate situations and solve problems;

CGE4f - applies effective communication, decision-making, problem solving, time and resource management skills;

CGE3f - examines, evaluates and applies knowledge of interdependent systems (physical, political, ethical, socio-economic and ecological) for the development of a just and compassionate society;

CGE5a - works effectively as an interdependent team member.

Strand(s): Scientific Inquiry: Science in Media; Chemistry: Interactions of Common Materials

Overall Expectations

CIMV.03 - analyse how material interactions affect our daily lives;

SIMV.03 - evaluate claims and presentations of science-related information in media.

Specific Expectations

CIM3.01 - research the interactions of materials that are used in daily life;

CIM3.02 - analyse the costs and benefits of a specific material with reference to its interactions with other materials in the environment;

CIM3.03 - communicate an opinion, supported by evidence about the use of a particular material, with consideration for both its physical and chemical interactions;

SIM3.01 - formulate testable questions about science-related claims and representations in the media;

SIM3.02 - develop procedures to assess these claims and representations, using information research and/or laboratory investigations.

Prior Knowledge & Skills

- Acquisition of operator licences for using various laboratory equipment, safety, lab skills from Activity 3.2
- An understanding of formulating testable questions, organizing information collected from lab investigations, and developing procedures from the Inquiry strand
- Knowledge of literacy skills, e.g., reading for information, understanding information
- An understanding of how to create a plus/minus analysis from Unit 1: Inquiry: Science in Media
- Safe and appropriate use of the Internet for research

Planning Notes

- Prepare a list of items for the investigation that include both synthetic and natural products. This list might include but is not limited to: natural and synthetic dyes, fibres, cleaners, cosmetics, etc.
- Make arrangements to access a computer lab/resource centre prior to the beginning of activity 3.4.2.
- Consider consulting with the librarian or the library technician to prepare a list of suggested resources for students.
- Students may require Internet passwords and library cards in order to access information.

Teaching/Learning Strategies

3.4.1 How Good Are Your Investigative Skills?

- The teacher chooses a variety of synthetic and natural fibres, dyes, cosmetics, indicators, etc., with consideration given to safety in the lab.
- The teacher provides a list of equipment: different sizes of beakers and graduated cylinders, scales, a watch glasses, a variety of tongs, and scissors.
- Working in pairs, students plan their investigation to identify and record advantages and disadvantages for using natural versus synthetic materials. Students present their plan for approval before conducting their investigation.

3.4.2 How Good Are Your Research Skills?

- Students perform media-based research to list the advantages and disadvantages of both their natural and synthetic products. To further their preparation for Unit 5: Community Action Plan, teachers should guide students to look specifically at the environmental impacts of these products.

3.4.3 What Are the Costs and Benefits of Using Natural vs. Synthetic Materials?

- Using the information compiled from the investigation and the media-based research, students put together a costs and benefits analysis of natural versus synthetic products. This could be done as a class discussion and the information could be displayed on the board or the overhead.

3.4.4 State Your Opinion

- With the information provided throughout this activity, students write one paragraph stating an opinion about whether they believe natural or synthetic products should be used and why.

Assessment & Evaluation of Student Achievement

See Assessment & Evaluation of Student Achievement in Overview, p. 8.

- In activity 3.4.1, the skills used throughout the investigation are assessed for Inquiry using a checklist.
- In activity 3.4.2, the list of advantages and disadvantages of both the natural and synthetic products are evaluated for Knowledge/Understanding and Communication using a rubric.
- In activity 3.4.4 the opinion piece is evaluated for Communication and Making Connections using criteria with marking scheme.

Resources

Science Resources

Print

Science Teachers of Ontario. *Stay Safe*. Toronto: STAO, 2002. ISBN 1-894592

Websites

American Chemical Society – www.chemistry.org

Bill Nye the Science Guy – www.nyelabs.com

Centre for Environmental Education Web Resources

– <http://weblinks.schoolsgogreen.org> Discovery.com

– <http://www.discovery.com>

Software

Smart Ideas. Ministry-licensed OSAPAC – Graphic organizers

Resources for Catholic Teachers

Websites

Eastern Ontario Catholic Curriculum Cooperative – <http://www.eoccc.org>

Faith and the Common Good – <http://www.faith-commongood.net>

Unit 4: Physics: Using Electrical Energy

Time: 26 hours

Unit Description

The growing demand for electrical energy has important implications for all communities, influencing quality of life and the state of the environment. Students increase awareness and understanding of issues linked to the generation and use of electrical energy. The activities emphasize the skills of collaboration, safe investigation, numeracy, media literacy, and communicating with an audience. The first activity, which continues throughout the unit, helps students to build an understanding of the terminology used in the study of Electrical Energy. Students gain an awareness of our reliance on electrical energy and an understanding of the energy conversions associated with the use of electricity. They compare electrical appliances and simple machines with respect to energy, power, current, and potential difference through laboratory investigations. Students design and build a device that generates electrical energy and make modifications to increase its output. They expand their understanding of stewardship and their responsibility as energy conservers by researching methods of generating electricity; analysing social, economic, and/or environmental implications; identifying consumption patterns; and designing and implementing a plan to reduce the consumption of electrical energy.

Unit Synopsis Chart

Activity/ Time	Learning Expectations	Assessment & Evaluation Tasks, Tools, & Categories	Tasks
4.1 Physics Terminology Licence .5 hours	PEEV.01, PEE1.02 CGE2b, 2d	4.1: Terminology licence is evaluated for Communication using a checklist at the end of the unit.	Students: • complete a Physics Terminology Licence throughout the unit.
4.2 Using Electricity 3.5 hours	PEEV.01, .02, PEE1.02, 1.03, 1.04, 2.04 SIMV.02, SIM2.04 CGE5a	4.2.1: Graphic organizers are assessed by the teacher for Knowledge/Understanding, and Communication. 4.2.2: Small appliance lab report is assessed for Knowledge/ Understanding and Communication using anecdotal feedback.	Students: • categorize household appliances and school/workplace machinery according to purpose and released forms of energy using graphic organizers; • read electrical information from a variety of small appliances/ machines, operate the appliance for a given period of time, and calculate energy use using power rating and time of operation and the formula $E = Pt$.

Activity/ Time	Learning Expectations	Assessment & Evaluation Tasks, Tools, & Categories	Tasks
4.3 Practical Energy 15 hours	PEEV.01, .02, PEE1.02, 1.03, 2.03, 2.04 CIMV.02, CIM2.05 SIMV.01, .03, SIM1.03, 3.03 CGE2c	4.3.1: Each stage of earning the Operator's Licence is peer- and teacher-assessed during the process, then the final component in each stage is evaluated for Inquiry using a checklist. 4.3.2: Lab report is evaluated for Knowledge/Understanding and Communication using a rubric. 4.3.3: Electrical generation plan, observations, and calculations are assessed by the teacher for Knowledge/Understanding, and Inquiry using criteria with marking scheme. 4.3.3: Modified plan, observations, and calculations are evaluated for Knowledge/Understanding and Inquiry using criteria with marking scheme. 4.3.4: Media piece is evaluated for Communication using a rubric.	Students: <ul style="list-style-type: none"> • obtain or renew their three-part Electrician Operator's Licence; • construct a simple circuit, measure voltage and current for a given time period, and calculate the power and energy output of the loads; • repeat their measurements and calculations after increasing the energy at the source; • build, modify, and promote the sale of an electrical generating device.
4.4 Generating Electricity 7 hours	PEEV.01, .02, .03, PEE1.01, 1.02, 1.04, 2.01, 2.05, 3.01, 3.02 BLTV.02, BLT2.06 SIMV.02, SIM2.02 CGE3f, 7i, 7j	4.4.1: Graphic organizers are evaluated for Inquiry, Communication, and Making Connections using criteria with marking scheme. 4.4.2: Graphs are assessed for Inquiry and Communication. 4.4.2: Electricity consumption reduction plan is assessed by the teacher for Making Connections and Communication. 4.4.2: Consumption reduction plan report is evaluated for Making Connections and Communication using a rubric.	Students: <ul style="list-style-type: none"> • participate in a jigsaw activity to conduct media-based research about methods of generating electricity from other energy sources; • graph and analyse electrical energy consumption data from home, school, or workplace; • examine a case study about Blackout 2003; • design, implement, and report on a plan to reduce electricity consumption in the home, school, or workplace.

Activity 4.1: Physics Terminology Licence

Time: 30 min, then ongoing throughout unit.

Description

Students complete a Physics Terminology Licence to further emphasize the importance of learning new vocabulary terms throughout this unit and course. Students use the most important words, define them in their own words, and include a diagram where appropriate. The definitions are placed in the portfolio and can be used for other activities.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE2b - reads, understands and uses written materials effectively;
CGE2d - writes and speaks fluently one or both of Canada's official languages.

Strand(s): Physics: Using Electrical Energy

Overall Expectations

PEEV.01 - explain the generation, measurement, and conversion of electricity.

Specific Expectations

PEE1.02 - define and describe electrical concepts.

Prior Knowledge & Skills

- Experience creating vocabulary lists in other units and grades

Planning Notes

- Prepare a list of important physics terms

Teaching/Learning Strategies

- Students receive a list of important physics terms that they write on their Physics Terminology Licence; suggested terms include: energy, electrical energy, energy conversion, power, watt (W), kilowatt (kW), Joule (J). (See Appendix 4.1.1: Sample Terminology Licence.)
- Students define as many terms as possible in their own words using text, notes, and teacher assistance.
- Students draw diagrams for terms or match diagrams provided by the teacher.
- This activity continues throughout the unit. Each time a new term is introduced students have the opportunity to complete a section of their licence.

Assessment & Evaluation of Student Achievement

See Assessment & Evaluation of Student Achievement in Overview, p. 8.

- The licence will be evaluated for Communication using a checklist at the end of the unit.

Appendix 4.1.1: Sample Terminology Licence

Term	Definition	Diagram or Graphic
Energy		
Electrical Energy		
Energy Conversion		
Power		
Watt		
Kilowatt		
Joule		

Activity 4.2: Using Electricity

Time: 3.5 hours

Description

Students begin their examination of the use of electrical appliances by identifying the appliances with which they are familiar from everyday use at home, in school, and in the workplace. They classify each appliance according to the type of energy conversion that takes place during its use. Students learn how to identify the power rating of an electrical appliance by examining its label. They calculate the energy consumed during the operation of a device for a given amount of time.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE5a - works effectively as an interdependent team member.

Strand(s): Physics: Using Electrical Energy; Scientific Inquiry: Science in Media

Overall Expectations

PEEV.01 - explain the generation, measurement, and conversion of electricity;

PEEV.02 - investigate the factors that affect the generation and use of electricity;

SIMV.02 - investigate science-related information presented in print and electronic media, using appropriate research and reporting skills.

Specific Expectations

PEE1.02 - define and describe electrical concepts;

PEE1.03 - determine quantitatively and/or qualitatively the energy and power associated with electrical devices;

PEE1.04 - identify the range of uses for electrical energy in our society and the energy conversions involved;

PEE2.04 - determine and record the electrical energy and power of electrical device;

SIM2.04 - organize and communicate information collected from lab investigations and information research, using graphic organizers.

Prior Knowledge & Skills

- Use of a calculator
- Use of a thermometer to measure temperature

Planning Notes

- Prepare all handouts prior to beginning the activity.
- Many of the resources included at the end of this activity may be useful in further lesson planning and could be referenced prior to planning Activity 4.3 and 4.4.

4.2.2 Investigating Electrical Appliances

- Provide exemplars of mathematical problem-solving methods for students to reference. The teacher should be prepared to model/demonstrate these problem-solving methods.
- A consistent format for algebraic formulae and/or word equations should be used throughout the activity.
- The use of calculators with a display that shows all steps may be helpful for some students. (**Note:** Teachers may need to contact the math department to inquire about calculator availability.)

- Some students may require additional support to experience success using formulas and performing calculations. Simple plug-in equations are recommended. The use of the Kagan structure Rally Coach (one student coaches the other through an algorithm, then they reverse roles, both working and coaching out loud) could be very helpful in developing students' abilities to complete calculations.
- Provide a variety of different hairdryers or have students bring in hairdryers with different power ratings. Alternatively, hand dryers found in the school can be used for the experiment. Be sensitive to the economic situations of students, which may affect their ability to bring in a functional and safe hairdryer. Check that the hairdryers are safe to use prior to the experiment. Paper towels need to be wet repeatedly.
- This activity requires several different appliances that may be available in the staff room kitchen, cafeteria, broad-based technology food lab, or cosmetology lab. Collect the required appliances in advance. If necessary, the label may be copied if the device cannot leave its area of use.
- Electrical information on appliances may include, along with power rating in watts (W): potential difference (voltage) in volts (V), frequency in hertz (Hz), and current (amperage) in amps (A). (**Note:** Not all appliances/machines have a current (amperage) rating. Computer printers, telephones, and power bars should have this information.) Students may require support in identifying the most important information on labels.
- Teachers should be familiar with the safe use of these electrical appliances before introducing them to students. Microwave ovens, kettles, and coffee makers should never be operated while empty. Check lab outlets and circuitry prior to conducting this activity to prevent overloading and circuit shut-off.

Teaching/Learning Strategies

4.2.1 Energy Conversions in Electrical Appliances

- In a full-class brainstorming exercise, students offer the names of household/workplace appliances that use electrical energy.
- Using the board, overhead/LCD projection, or chart paper, the teacher records the item names and leads a discussion on the use(s) of each item, noting the use(s) for each appliance on the recording 'page.'
- The teacher introduces the concepts of energy, electrical energy, forms of energy, and energy conversion, and leads a discussion about the form(s) of energy that result from the conversion of electrical energy in each operating appliance, noting each conversion against each item.
- Students record the definition and description of energy, electrical energy, and energy conversion and add them to the Terminology Licence.
- The teacher introduces/reviews the use of graphic organizers, presents models, and discusses a corresponding assessment tool with the class. Students who have completed the LDCC Grade 9 Science course can support their peers.
- Each student refers to the board work/projection development and the assessment tool and creates two graphic organizers, one that organizes items according to their use and a second that organizes items according to the form(s) of energy released while in operation. See Appendix 4.2: Sample Graphic Organizer of Appliances that Convert Electrical Energy.
- Students submit the graphic organizers for assessment.

4.2.2 Investigating Electrical Appliances

- Students participate in a class discussion about making an effective and responsible contribution during group work.
- Working in small groups, students use a stopwatch to determine the length of time a hairdryer takes to dry a paper towel. The group is provided with a damp paper towel, a dry paper towel, and a hairdryer. Students dry the wet paper towel until the colour is the same as the dry paper towel, and record the time required (in seconds), the type of energy produced, and any other information, e.g., model, numbers.

-
- Students compile the data as a class and, with the assistance of the teacher, organize and compare results. Students observe the relationship between the time it took to dry the paper towel and the power rating of the hairdryer. Through a class discussion, the teacher extends these concepts to show the relationship among energy, power, and time.
 - The teacher relates the concepts of energy, power, and time to the formula $\text{Energy} = \text{Power} \times \text{time}$ ($E = Pt$) and outlines a problem-solving technique for calculating energy, using the data collected in the hairdryer experiment. The teacher outlines the units for each of the quantities the students will be measuring (energy in joules, power in watts, time in seconds).
 - Students are provided with data table with headings such as Item, Power (W), Time of Use (s), Energy Used (J), Form(s) of Energy Detected. Students complete this data table using the class data from the hairdryer experiment.
 - Students add power, watts, energy, and joules to the Terminology Licence.
 - Students prepare and submit a report that includes a statement of purpose, a completed table, a sample calculation, and answers to questions for assessment.
 - The teacher sets up stations about the classroom to display a number of household/workplace appliances, e.g., microwave oven, toaster, toaster oven, kettle, coffee maker, computers, printers and/or pieces of science equipment, e.g., microscope, centrifuge, directing students to the location of the electrical information marked on each item, particularly, to the power rating.
 - The teacher demonstrates the investigation's procedure, clearly defining student roles, reviewing the safe handling and operation of electrical equipment, and identifying the data that will be collected in the experiment.
 - Using the data table from the hairdryer experiment, students design a suitable data table and receive feedback from the teacher before proceeding with the experiment.
 - Working in small groups, students assume roles: a Timer measures time at each station; a Safety Inspector is responsible for the collection of equipment, its handling, operation, and safe return. An Information Officer carefully handles the item, locates electrical information, and shares the information with the group; an Operator safely plugs in, turns on, turns off, and unplugs the item. As a group moves from station to station, student roles change. By the end of the investigation, students serve at each role at least once. Each student is responsible for her/his own record keeping.
 - At each station, students obtain the power rating of the appliance/equipment, and operate the item for thirty seconds (30 s). Students observe the form(s) of energy generated by each operating item. Each student records all observations in the table.
 - The teacher distributes and discusses the corresponding assessment tool with students.
 - Students prepare and submit a report that includes a statement of purpose, a completed table, a sample calculation, and answers to questions for evaluation.

Assessment & Evaluation of Student Achievement

See Assessment & Evaluation of Student Achievement in Overview, p. 8.

- In activity 4.2.1, the graphic organizers are assessed by the teacher for Knowledge/Understanding and Communication.
- In activity 4.2.2, the lab report is assessed by the teacher for Knowledge/Understanding and Communication using anecdotal feedback.

Resources

Science Resources

Print

Hirsch, A.J. *Nelson Physics 12: College Preparation*. Thomson Canada Ltd., 2004.
ISBN 0-17-626530-9

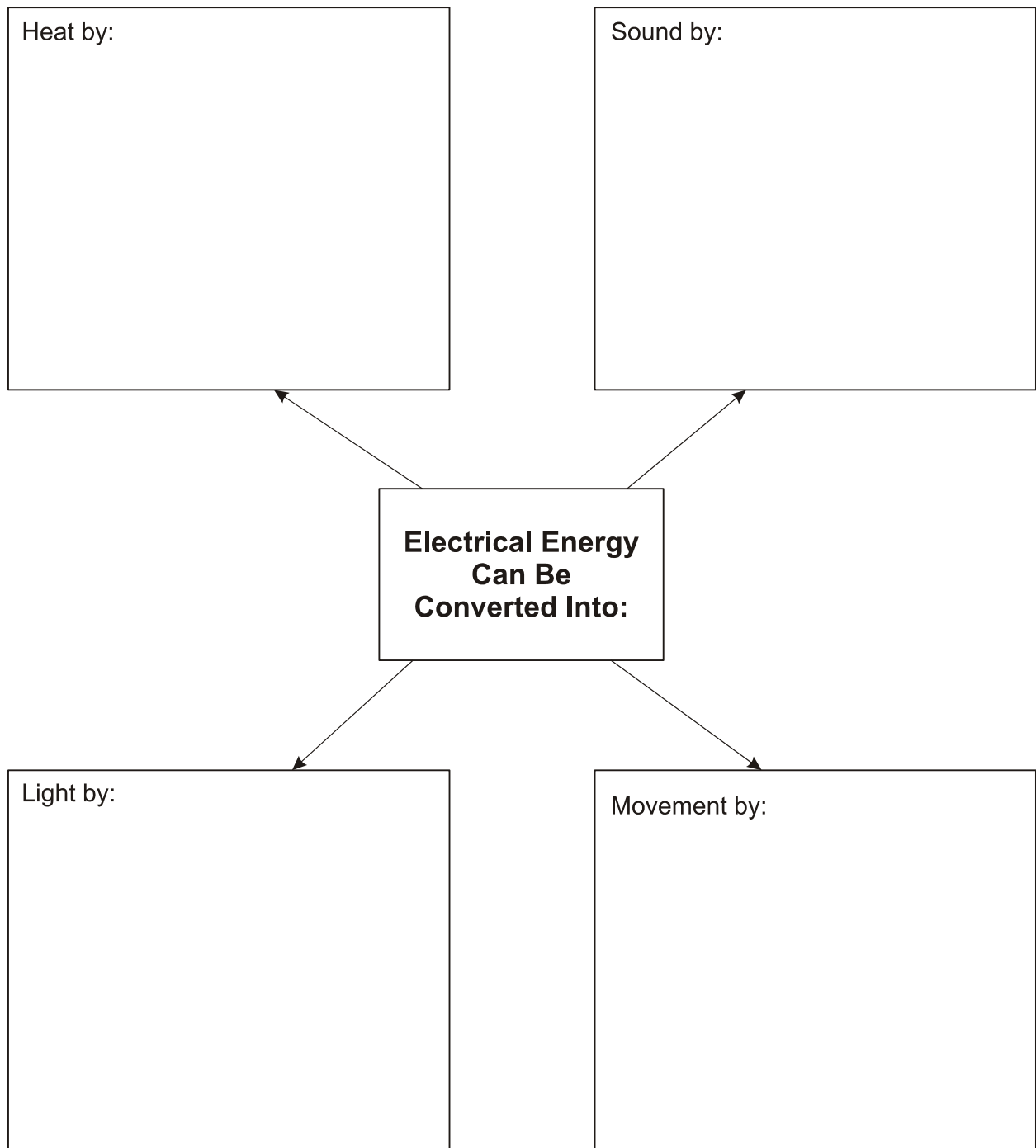
Novikow, Igor, B. Heimbecker, and D. Bosomworth. *Physics: Concepts and Connections*. Toronto: Irwin Publishing Ltd., 2001. ISBN 0-7725-2872-1

Plumb, D., B. Ritter, E. James, and A.J. Hirsch. *Science 9*. Toronto: Nelson, 1999. ISBN 0-17-612032-7

Wolfe, E., C. Clancy, G. Jasper, D. Lindenberg, D. Lynn, F. Mustoe, and R. Smythe.

SCIENCEPOWER™ 9. Toronto: McGraw-Hill Ryerson, 1999. ISBN 0-07-560361-6

Appendix 4.2: Sample Graphic Organizer of Appliances that Convert Electrical Energy



Activity 4.3: Practical Energy

Time: 15 hours

Description

Students perform a series of three tasks to earn or renew their Electrician Operator's Licence. Students build simple circuits, measure the voltage and current for a given time, and calculate the power and energy output of the loads. They repeat these measurements and calculations after increasing the energy at the source. Students build an electrical generating device, modify it to increase its energy output, and create a media piece designed to 'sell' their device to their classmates.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE2c - presents information and ideas clearly and honestly and with sensitivity to others.

Strand(s): Physics: Using Electrical Energy; Chemistry: Interactions of Common Materials;
Scientific Inquiry: Science in Media

Overall Expectations

PEEV.01 - explain the generation, measurement, and conversion of electricity;

PEEV.02 - investigate the factors that affect the generation and use of electricity;

CIMV.02 - investigate the types and rates of interactions between commonly used materials through laboratory activities;

SIMV.01 - explain how science-related information is presented in print and electronic media for different purposes and audiences;

SIMV.03 - evaluate claims and presentations of science-related information in media.

Specific Expectations

PEE1.02 - define and describe electrical concepts and their units;

PEE1.03 - determine quantitatively and/or qualitatively the energy and power associated with electrical devices;

PEE2.03 - modify the electrical device they built to increase the amount of electrical energy it produces;

PEE2.04 - determine and record the electrical energy and power of electrical device;

CIM2.05 - communicate the results of investigations using a variety of oral, written, and graphic formats;

SIM1.03 - explain how different formats used in the media to present science target specific audiences;

SIM3.03 - evaluate the investigation and suggest improvements.

Prior Knowledge & Skills

- Prior experience with electricity concepts from Grade 9 LDCC Physics unit, SNC 1P/1D, including following circuit diagrams, use of symbols, and terminology, e.g., load, cell, switch
- Use of a calculator
- Experience using the Internet to search for information
- Familiarity with reading analog or digital meters, or multimeters

Planning Notes

4.3.1 Electrician Operator's Licence/Licence Renewal

- This activity acts as a licence renewal for students who were successful in LDCC Grade 9 Science and provides opportunity for these students to act as student mentors for those who are seeing and performing this series of tasks for the first time.
- Students who are unable to successfully earn all three parts of the Electrician's Operator's Licence should be paired with another student who has earned the licence for these activities.

- The circuit symbols used in this activity should be consistent with those used in other science courses and broad-based technology courses offered at the school.
- This activity is based on analog, multi-scale meters. Teachers using meters with digital display or multimeters modify the activity to suit the equipment at hand.
- Electric energy sources used must be within the rating range of connecting wires and loads.
- Students revisit electrical information label plates found on appliances and define and describe current (amperage) and potential difference (voltage).
- Students should be reminded to only measure current and voltage of low-powered sources such as batteries.

4.3.2 Investigation: Calculating Power and Energy from Electrical Circuits

- A consistent format for algebraic formulae and/or word equations should be used throughout the activity.
- The use of calculators with a display that shows all steps may be helpful for some students. (**Note:** Teachers may need to contact the math department to inquire about calculator availability.)
- Some students may require additional support to experience success in qualitative observations and calculations of power and energy. The use of the Kagan structure Rally Coach (one student coaches the other through an algorithm, then they reverse roles, both working and coaching out loud) could be very helpful in developing students' abilities to complete calculations.

4.3.3 Project

- Materials for this activity may be provided by the students or by the school.
- Book the library resource centre and/or the computer lab in advance.
- Collect a variety of samples of media pieces for students to use as models. The nature of the media piece in this activity could reinforce forms developed in previous strands or could introduce a new form.

Teaching/Learning Strategies

4. 3. 1 Electrician Operator's Licence/Licence Renewal

- The teacher begins the lesson by discussing the purpose, form, and use of circuit symbol diagrams.
- The teacher sets up stations about the classroom. Each station contains an actual circuit component and a label with the name of the device.
- Given a handout listing circuit symbols – see Appendix 4.3.1: Matching Circuit Symbols (Sample Chart) – students match each circuit symbol to its corresponding circuit component. The name of each component is written next to its corresponding symbol, e.g., connecting wire, light bulb, dry cell(s)/DC power supply, resistor, switch, motor, fuse, ammeter, voltmeter, galvanometer.
- Students participate in a think/pair/share/square exercise, as directed by the teacher, to confirm or correct their work. A complete and corrected handout, assessed and approved by the teacher, leads to planning and drawing simple circuit diagrams.
- Given the names of the components of a simple circuit on a handout, students draw a proper circuit diagram using only circuit symbols, e.g., connecting wire, light bulb, dry cells/DC power supply, switch (open), ammeter, voltmeter. See Appendix 4.3.2: Drawing Circuit Diagrams (Sample Handout).
- Students participate in a think/pair/share/square exercise to confirm or correct their work. They submit a complete and corrected handout to the teacher for evaluation. Complete and corrected handout satisfies the first stage in earning the licence. Students are encouraged to be honest and sensitive to their peers when correcting work.

-
- The teacher outlines laboratory and electrical safety and procedural protocols for building circuits.
 - The teacher provides those circuit components that match the circuit diagram exercise.
 - In pairs or small groups, students build a simple circuit from the diagram generated by the circuit diagram exercise. Students receive ongoing feedback while they build their circuits. A successful construction, assessed and approved by the teacher, satisfies the second stage in earning the licence.
 - Students safely dismantle the circuit.
 - Using a demonstration/projection meter or facsimile, the teacher demonstrates how to read both an ammeter and a voltmeter.
 - Given figures of ammeters and voltmeters on a handout, students state illustrated current (amperage) and potential difference (voltage) readings.
 - Given figures of ammeters and voltmeters on a handout, students draw ‘needles’ to illustrate given current (amperage) and potential difference (voltage) values.
 - Students participate in a think/pair/share/square exercise to confirm or correct their work. They submit a complete and corrected handout to the teacher for assessment.
 - In pairs or small groups, students reconstruct the ‘open’ circuit that led to earning stage two of the licence. At a source output setting determined by the teacher and with the switch closed, students read and record the value on the ammeter and on the voltmeter (or values on the multimeter.) Correct reading satisfies the third and final stage in earning the licence.
 - Students safely dismantle the circuit.

4.3.2 Investigation: Calculating Power and Energy from Electrical Circuits

- Students construct a simple circuit built from dry cell(s)/DC power supply, connecting wires, a switch (open), a lamp/motor, a voltmeter, an ammeter. The teacher provides stopwatches.
- At a source setting and a time determined by the teacher, students close the switch for the fixed time interval, read and record the meter values, record the time and note the forms of energy released at the load (heat and light from a lamp, heat, motion and sound from a motor).
- Students open the switch and, as directed by the teacher, increase the energy output from the source (two batteries in series; increasing the setting on the DC supply). For a fixed time interval, the students note any ‘intensity’ changes in the forms of energy released at the load, then read and record the meter values, and record the time.
- Students safely dismantle the circuit.
- The teacher relates the concepts of power, current, and potential difference to the formula $\text{Power} = \text{current} \times \text{potential difference}$ ($P = IV$) and revisits the problem-solving technique to calculate power, given current (in amps) and potential difference (in volts). The watt is explained as $1 \text{ watt} = 1 \text{ amp-volt}$ ($1 \text{ W} = 1 \text{ AV}$).
- The teacher relates the concepts of energy, current, potential difference, and time to the formula $\text{Energy} = \text{current} \times \text{potential difference} \times \text{time}$ ($E = IVt$) and revisits the problem-solving technique to calculate energy, given current (in amps), potential difference (in volts), and time (in seconds). The joule is re-explained as $1 \text{ joule} = 1 \text{ amp-volt-second}$ ($1 \text{ J} = 1 \text{ AVs}$).
- Students calculate values for power and energy from their data, calculate the changes in power and energy resulting from the change in the energy source, and compare the calculated changes to the qualitative observations of the energy changes at the load.
- Students submit their lab report for evaluation.

4.3.3 Project

- The teacher demonstrates the construction of a ‘classical’ voltaic cell and a ‘classical’ voltaic pile, making reference to nature and position of electrodes and the nature and concentration of the electrolyte.
- Students access the Internet and, with given URLs, find designs for voltaic cells and voltaic piles (electrical devices) constructed from simple household materials.
- Students choose one type of device and prepare a series of diagrams that illustrate materials and steps taken toward construction.
- After approval of materials and design by the teacher, students construct the device and plan a procedure to qualitatively and quantitatively determine the device’s energy output and power. They communicate this plan orally to the teacher, and make any necessary adjustments based on the feedback they receive. Once they have obtained the teacher’s permission, they carry out their plan, recording observations as they proceed and making necessary calculations. They submit this electrical generation plan, observations, and calculations to the teacher for assessment.
- Students modify the plan of the device to increase energy output and record changes on the original planning diagram. They submit these modifications for approval and make any changes necessary.
- Students implement the teacher-approved modifications and verify, qualitatively and quantitatively, an increase in energy output and power, recording observations as they proceed and making necessary calculations.
- Students safely dismantle the devices.
- Students submit their modified plan, observations, and calculations for evaluation.

4.3.4 Creating an Advertisement

- The teacher revisits material learned in Unit 1, provides samples of advertisement flyers, and discusses how methods of presenting media are connected to purpose and the audience.
- The teacher reviews the tool for evaluating a media piece.
- Students plan, design, and create an advertisement flyer, promoting their device for sale to a classmate.
- Students submit the media pieces for evaluation.

Assessment & Evaluation of Student Achievement

See Assessment & Evaluation of Student Achievement in Overview, p. 8.

- In activity 4.3.1, each stage is peer- and teacher- assessed during the process, then the final component in each stage is evaluated for Inquiry using a checklist.
- In activity 4.3.2, the lab report is evaluated for Knowledge/Understanding and Communication using a rubric.
- In activity 4.3.3, the electrical generation plan, observations, and calculations are assessed by the teacher for Knowledge/Understanding, and Inquiry using criteria with marking scheme. The modified plan, observations, and calculations are evaluated for Knowledge/Understanding and Inquiry using criteria with marking scheme. The media piece is evaluated for Communication using a rubric.

Resources

Science Resources

Websites

Fun with Franklin: Instructions for how to make a lemon battery

– <http://www.ushistory.org/franklin/fun/lemon.htm>

Ultra-simple Electric Generator: Instructions for building a simple generator

– <http://www.amasci.com/amateur/coilgen.html>

Institute of Electrical and Electronics Engineers (IEEE)

– <http://www.ieee.org/organizations/eab/precollege/tispt/pdf/lessons/flashlight.pdf>

Salt River Project (SRP) – <http://www.srpnet.com/community/kids/>

Lemon Battery: Using a Lemon to Create a Voltaic Cell

– <http://education.magnet.fsu.edu/professional/recertification/project/module8.pdf>

Electricity & Magnetism & Renewable Energy – <http://www.juliantrubin.com/electricityprojects.html>

What about batteries? – <http://www.usoe.k12.ut.us/curr/science/core/plans/battery.html>

All Science Fair Projects: Voltaic Pile Information

– http://www.all-science-fair-projects.com/science_fair_projects_encyclopedia/voltaic_pile

Voltaic Pile Experiment: How Stuff Works – <http://science.howstuffworks.com/battery4.htm>



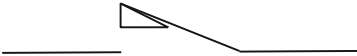
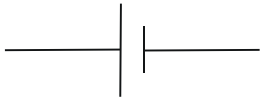


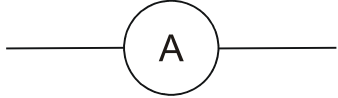
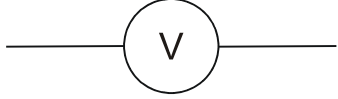
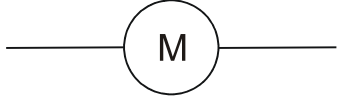

Workplace Link Resources

Print

A Case Study in Battery Technology – a resource package published by the Manufacturing

Resource Corporation of Ontario (MRCO) and the Ontario Centre for Materials Research (OCMR), 1991.

Appendix 4.3.1: Matching Circuit Symbols (Sample Chart)

Name	Electrical Symbol
	
	
	
	
	
	
	
	
	
	

Appendix 4.3.2: Drawing Circuit Diagrams (Sample Handout)

Instructions: Using the circuit symbols, draw the circuit diagrams in the space below.

1. Draw a circuit containing a closed switch, two light bulbs, and connecting wires.
2. Draw a circuit containing a load, a light bulb, a battery, and connecting wires.
3. Draw a circuit containing an open switch, a multimeter, a battery, a light bulb, and connecting wires.
4. Draw a circuit containing an open switch, a closed switch, light bulbs, and two batteries.

Activity 4.4: Generating Electricity

Time: 7 hours

Description

Students participate in a jigsaw, in which they use media-based research to collect information about one method of generating electricity from another energy source and share the results of their research in small groups. Students summarize the results of the jigsaw activity in a series of graphic organizers. Students examine electricity consumption data from home, school, and the workplace to identify patterns. Through a case study about the Blackout of 2003, students gain awareness of the energy consumption issues our society faces. They design, implement and reflect on a plan to reduce electrical energy consumption in their home, school, or workplace.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE3f - examines, evaluates and applies knowledge of interdependent systems (physical, political, ethical, socio-economic and ecological) for the development of a just and compassionate Society;

CGE7i - respects the environment and uses resources wisely;

CGE7j - contributes to the common good.

Strand(s): Physics: Using Electrical Energy; Biology: Living Together;
Scientific Inquiry: Science in Media

Overall Expectations

PEEV.01 - explain the generation, measurement, and conversion of electricity;

PEEV.02 - investigate the factors that affect the generation and use of electricity;

PEEV.03 - analyse the social, economic, and/or environmental implications of the sources and uses of electrical energy;

BLTV.02 - investigate, using appropriate laboratory and research skills, the implications of organisms existing in communities;

SIMV.02 - investigate science-related information presented in print and electronic media, using appropriate research and reporting skills.

Specific Expectations

PEE1.01 - describe different methods of generating electricity from other forms of energy;

PEE1.02 - define and describe electrical concepts and their units;

PEE1.04 - identify the range of uses for electrical energy in our society and the energy conversions involved;

PEE2.01 - locate and select information from various sources to identify factors affecting generation and use of electricity;

PEE2.05 - communicate information using appropriate formats for specific purposes and audiences;

PEE3.01 - compare technologies used for generating electrical energy, including their social, economic, or environmental implications;

PEE3.02 - design and implement a plan to reduce electrical consumption at home, at school, or in a workplace, based on identified consumption patterns;

BLT2.06 - explain and interpret observations by summarizing patterns obtained from graphing data, organizing information, and communicating orally and in writing;

SIM2.02 - research science-related information from a variety of electronic and other sources.

Prior Knowledge & Skills

- Familiarity with a variety of graphic organizers
- Understanding of media-based research skills
- Knowledge of graphing skills

Planning Notes

4.4.1 Generating Energy

- Book the library/resource centre and/or computer lab in advance of this activity.
- Make sufficient copies of appropriate graphic organizers for student use during the various stages of this activity.
- Collect sources of information that provide students with material at a suitable reading level, and consider the use of audio and video resources in addition to print resources.

4.4.2 Consuming Electricity

- Electricity consumption data may be obtained from residential hydro bills, the school board facilities department, and local hydroelectric utilities.
- Some students may require additional support in the gathering and organizing of media-based research material.

Teaching/Learning Strategies

4.4.1 Generating Energy

- The teacher organizes students into expert groups for research and home groups for presentations, following the structure for a jigsaw cooperative learning model. Students are provided with a graphic organizer to help them summarize the results of their own expert group research, and to record the results of other expert groups (see Appendix 4.4: Sample Graphic Organizer to Summarize Research on Methods of Alternative Energy Generation).
- Students work in expert groups to conduct media-based research about one method of generating electricity from another form of energy, e.g., wind, water, solar, coal, nuclear. The research should allow students to briefly describe the method that is used to generate the electricity, and to outline the advantages and disadvantages of the method. They summarize the results of their research using a graphic organizer. Students receive feedback from the teacher about their graphic organizer, and they are given the opportunity to modify it, if required. Students are encouraged to use their resources wisely.
- Students work in home groups, with each member of the home group representing a different source of energy used for generating electricity. Each student takes a turn reporting the results of the expert group's research. Students in the home group work as a team to complete a graphic organizer summarizing the results of each expert group's research. Students receive feedback from the teacher about their graphic organizer, and they are given the opportunity to modify it, if required.
- The teacher leads a discussion about the different types of energy generation studied. The focus of the discussion is to identify similarities in each of the methods of energy generation, as well as the unique characteristics of each one.
- Individually, students complete a graphic organizer, comparing at least two different methods of generating electrical energy with a focus on the economic, social, or environmental impact of the methods, and they submit the organizer for evaluation.

4.4.2 Consuming Electricity

- The teacher provides students with electricity consumption data from a household and the school or another workplace and reviews the peer assessment graphing checklist with the class.
- Students work in pairs. One student is responsible for graphing the consumption data from the household, and the other student is responsible for graphing the consumption data from the school. After the graphs are constructed, the pair works together to identify hourly, daily, and monthly consumption patterns that emerge from the graphs.
- Two pairs of students join to form a group of four. Students who completed graphs about the same data switch graphs and provide feedback. The group of four discusses the consumption patterns they identified. During these discussions, the teacher moves from group to group to provide feedback.
- The teacher provides students with a case study, including a graph, about the Blackout of 2003, which occurred in Ontario and the Northern United States.
- Students answer a series of questions related to the case study and graph and submit them for teacher feedback.
- The teacher leads a class brainstorming discussion to identify ways to reduce electricity consumption at home, at school, and in the workplace. Students record the results of the brainstorming session on a graphic organizer.
- Working individually, students design an electricity consumption reduction plan for their home, or classroom. The plan includes a method for measuring the current level of electricity consumption, an outline of the steps that will be taken to reduce consumption, and a proposed period of time for implementation. For example, students may choose to measure the amount of electricity consumed in their home, during a one-week period prior to introducing the energy-saving measures, and then measure the energy consumption again for one week after introducing the energy-saving measures. They submit this plan to the teacher for assessment.
- Using the feedback from the teacher, students refine their plan, if necessary, and could implement the plan for an additional identified time period. Permission may be needed.
- Students prepare a report about the outcome of their electricity consumption reduction plan, identifying areas of success, areas which still need work, and any modifications that their plan requires. They submit this report to the teacher for evaluation.

Assessment & Evaluation of Student Achievement

See Assessment & Evaluation of Student Achievement in Overview, p. 8.

- In activity 4.4.1, graphic organizers comparing electrical generation methods are evaluated for Inquiry, Communication, and Making Connections using criteria with marking scheme.
- In activity 4.4.2, student-generated graphs are assessed for Inquiry and Communication; the electricity consumption reduction plan is assessed by the teacher for Making Connections and Communication; and the consumption reduction plan report is evaluated for Making Connections and Communication using a rubric.

Resources

Science Resources

Websites

Green Ontario – www.greenontario.org

Ministry of Community Safety and Correctional Services: Power Outage Information

– <http://www.mpss.jus.gov.on.ca/english/power/factsheet.html>

Canada Online: Energy Conservation in Homes in Canada

– <http://canadaonline.about.com/od/homeenergyuse/>

Energy Kid's Page – <http://www.eia.doe.gov/kids/>

Energy Kid's Page – <http://www.eia.doe.gov/kids/classactivities/Blackout2003IntSec.pdf>
CBC News – <http://www.cbc.ca/news/background/poweroutage/>
The Toronto Star
– <http://www.thestar.com/NASApp/cs/ContentServer?pagename=thestar/Render&c=Page&cid=1060963744029>
Canadian Geography – http://www.canadiangeographic.ca/blackout_2003/default.html
Planet Friendly.net – <http://www.planetfriendly.net/blackout.html>
FirstEnergy – www.firstenergycorp.com/kids/
Natural Resources Canada: Office of Energy Efficiency – <http://oee.nrcan.gc.ca/energuide/home.cfm>

Resources for Catholic Teachers

Websites

Eastern Ontario Catholic Curriculum Cooperative – <http://www.eoccc.org>
Faith and the Common Good – <http://www.faith-commongood.net>

Appendix 4.4: Sample Graphic Organizer to Summarize Research on Methods of Alternative Energy Generation

```
graph TD; A[Alternative Method of Energy Generation Being Researched:  
_____] --> B[How is power generated by this method?]; B --> C[Advantages of this method:]; B --> D[Disadvantages of this method:];
```

Alternative Method of Energy Generation Being Researched:

How is power generated by this method?

Advantages of this method:

Disadvantages of this method:

Unit 5: Community Action Plan

Time: 20 hours

Unit Description

Environmental concerns arise from the growing demand for electrical energy and the increased generation of electric power. Students demonstrate the skills and knowledge gained in prior units through the generation of an action plan and public awareness campaign. They learn personal accountability for the state of the environment and come to understand that their actions impact their community.

Students perform a variety of laboratory investigations into environmental concerns related to generating electricity, e.g., effects of acid rain, oil spills, greenhouse gases, particulate matter, and battery disposal. These investigations combine safe laboratory procedures; posing questions; collecting, organizing, and analysing data; and drawing conclusions. Using a variety of resources, students research the environmental effects of electrical power generation by chemical means on communities and environmentally friendly alternative power generation. The experimental and media-based research lead to the development, presentation, and implementation of a community-based action plan. This task addresses literacy and numeracy through media-based research, problem solving, communication, and presentation of the action plan and media campaign. Students are given opportunities for self-assessment and to receive teacher and peer feedback to improve their final product.

Unit Synopsis Chart

Activity/ Time	Learning Expectations	Assessment and Evaluation, Categories, Tasks & Tools	Tasks
5.1 Experimental- Based Research 6 hours	CIMV.02, .03, CIM2.01, 2.02, 3.01 BLTV.02, BLT2.04 SIMV.02, SIM2.04 PEEV.03, PEE3.01 CGE3b, 3c, 3d, 3f	5.1.1: Lab technique and Master Form are assessed for Inquiry and Communication with feedback given. 5.1.2: Experimental plan assessed for Inquiry and Communication using a checklist. 5.1.3: Observation table and graph are evaluated for Communication using a rating scale. 5.1.5: Hypothesis and conclusions are evaluated for Inquiry and Making Connections using a rubric.	Students • perform laboratory investigations into the following environmental concerns: - oil spills; - acid precipitation; - global warming; - particulate matter; - disposal of car batteries.

Activity/ Time	Learning Expectations	Assessment and Evaluation, Categories, Tasks & Tools	Tasks
5.2 Media-Based Research 5 hours	BLTV.02, BLT2.04 SIMV.02, SIM2.02, 2.03 PEEV.02, .03, PEE2.01, 3.01 CGE4f	5.2.1: The summary Table of Research and Making Judgements Master Form is evaluated for Communication, Inquiry and Making Connections using a rubric. 5.2.2: The summary table is evaluated for Communication, Inquiry, and Making Connections using a checklist/ rating scale.	Students: <ul style="list-style-type: none"> • view a video to increase their understanding of environmental concerns relating to power generation; • select and research one environmental concern investigated in Activity 5.1; • research environmentally friendly methods of generating electricity for their community, identifying both advantages and disadvantages.
5.3 Action Plan and Public Awareness Campaign 9 hours	SIMV.01, .02, .03 SIM1.02, 1.03, 2.04, 3.04 CIMV.03, CIM3.03 BLTV.03, BLT3.01 PEEV.02, .03, PEE2.05, 3.02 CGE5d	5.3.2: Graphic organizer and written component of the action plan are evaluated for Inquiry, Making Connections and Communication using a rubric. 5.3.3: Media piece for a Public Awareness Campaign is evaluated for Communication and Making Connections using a checklist; reflective questionnaire is evaluated for Communication using a rubric.	Students: <ul style="list-style-type: none"> • compile a list of concerns and benefits of generating electrical energy by chemical means and offer an environmentally friendly alternative; • design and present an action plan addressing an environmental concern; • design and create a media piece to be used in a Public Awareness Campaign.

Activity 5.1: Experimental-Based Research

Time: 6 hours

Description

Through laboratory investigations, students are introduced to various environmental concerns related to the generation of electricity. These investigations provide students with concrete, practical research information on oil spills, acid precipitation, the role of carbon dioxide in global warming, particulate matter in the atmosphere, and the effects of the improper disposal of car batteries on soil and/or water. Interest generated by completing these experimental investigations promotes the selection of topics for the media-based research in Activity 5.2. Self-, peer, and teacher feedback received during the earning of operator licences, e.g., safety, equipment, filtering in the Chemistry unit, prepares students for success in the lab-based evaluation for this activity.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE3b - creates, adapts, evaluates new ideas in light of the common good;

CGE3c - thinks reflectively and creatively to evaluate situations and solve problems;

CGE3d - makes decisions in light of gospel values with an informed moral conscience;

CGE3f - examines, evaluates and applies knowledge of interdependent systems (physical, political, ethical, socio-economic and ecological) for the development of a just and compassionate society.

Strand(s): Scientific Inquiry: Science in Media; Biology: Living Together;
Chemistry: Interaction of Common Materials; Physics: Using Electrical Energy

Overall Expectations

CIMV.02 - investigate the types and rates of interactions between commonly used materials through laboratory activities;

CIMV.03 - analyse how material interactions affect our daily lives;

BLTV.02 - investigate, using appropriate laboratory and research skills, the implications of organisms existing in communities;

SIMV.02 - investigate science-related information presented in print and electronic media using appropriate research and reporting skills;

PEEV.03 - analyse the social, economic, and/or environmental implications of the sources and uses of electrical energy.

Specific Expectations

CIM2.01 - select and use appropriate apparatus and apply WHMIS safety procedures for the handling, storage, disposal, and recycling of laboratory materials;

CIM2.02 - conduct experiments to investigate how materials can interact chemically;

CIM2.03 - conduct experiments to investigate how materials can interact physically;

CIM3.01 - research the behaviour of materials that are used in daily life;

BLT2.04 - make observations, directly or using technologies, to determine the benefits and challenges of living in communities;

SIM2.04 - organize and communicate information collected from lab investigations and information research using graphic organizers;

PEE3.01 - compare technologies used for generating electrical energy, including their social, economic, or environmental implications.

Prior Knowledge & Skills

- Acquisition of operator licences required for using various laboratory equipment, safety, lab skills, research, organization, graphing techniques
- Knowledge of different methods of generating electricity and their environmental consequences
- Experience creating an action plan
- Practice interpreting graphical data
- Knowledge of literacy skills, e.g., reading for information, reading for inference, reading graphical text

Planning Notes

- Readings and questions – brief synopsis – on acid precipitation, oil spills, and particulate matter should be collected and prepared ahead of time. These readings and questions can be used at the beginning of the activity to generate interest. These assignments also serve as a point to initiate research, and are meant as additions to portfolio and literacy practice – not as evaluations. Teachers could choose to assess these to assist students, if time permits.
- All templates should be prepared ahead of time.
- Copies of the Progress Chart (Appendix 5.1.1: Progress Chart: Unit 5) should be made and distributed to the students at the beginning of the unit.
- All evaluation tools should be prepared in advance to be shared with students prior to activity, e.g., rating scale for planning and conducting experiments.
- Lab materials should be collected and organized well ahead of time.
- Individual laboratory activities could be set up as stations for one large activity, rather than run separately, depending on time, student, and classroom needs.

5.1.1 Introductory Activity/Investigating Oil Spills

- Word-search or flash-card game should be prepared ahead of time and may also be used as a diagnostic tool.

5.1.3 Investigating Greenhouse Effect

- Pictures should be collected/prepared for global warming literacy activity, e.g., plants wilting in an arid environment; smokestacks at a factory.

5.1.4 Investigating Particulate Matter

- A guest speaker, e.g., air quality analyst, could be invited in from Environment Canada to make a presentation on air quality monitoring instead of having students do a reading. In this case, a question-based activity based on the presentation would replace the reading-based assignment.

Teaching/Learning Strategies

- The teacher gives each student a copy of the Progress Chart (Appendix 5.1.1: Progress Chart: Unit 5) for this unit.
- Students use this chart to track their progress throughout the unit, record their evaluation results for each activity, and to organize their time and work to meet the goals of the task.

5.1.1 Introductory Activity/Investigating Oil Spills

- When introducing the environmental concerns at the beginning of the unit, or in each of the literacy tasks, teachers could explain the importance of stewardship and wise management of resources, with specific reference to human impact on the environment. Students produce a reflection on these topics, or participate in a teacher-led discussion.
 - Using a checklist provided by the teacher, students organize their portfolios for the necessary licences and information needed to assist in performing this task.
 - Students review information pertinent to the task from their portfolio, e.g., safety, use of equipment, writing lab reports, formation of action plan.
 - The teacher provides a word-search or flash-card game to assist students in reviewing key vocabulary of this topic.
 - Students participate in a teacher-guided discussion to review the activities and types of environmental concerns involved in completing the task. The teacher could take this opportunity to introduce the students to the assessment tools. (**Note:** The above tasks are meant to be brief and expose students to concepts important for the final task.)
 - Students read and carefully follow given instructions to conduct experiments safely (refer to Appendix C). Students gather data on the effectiveness of various methods for cleaning oil spills off feathers, inanimate objects, and water. Suggested materials include containers with water, oil, and different objects (rocks, sticks, plastics, feathers, fur). The cleanup materials may include paper towel, sponges, cloth, borax, detergents, gauze, cotton balls, mineral oil, detergents and soaps, paper, etc. If lab space is limited, a class could be split so some students could work on reading assignments while others work on their lab investigations.
 - The teacher collects a completed Master Form, including their data, from the students. (**Note:** It may be helpful to remind students that a Master Form is a workplace term for a template.)
 - Students read a brief synopsis on oil spills and answer questions. The teacher gives feedback to assist student learning.
- #### 5.1.2 Investigating Acid Precipitation
- Students design and conduct a test to observe the effect of water from different sources of precipitation on granite and marble. Real or simulated precipitation should be made available for students, e.g., rain, snow, hail, sleet, dilute acid solutions. The activity may involve observations made using indicators, e.g., bromothymol blue, amount of gas formation on building materials (limestone, marble, metals, gravel.)

-
- The teacher evaluates the students using a checklist (technique, controls and safety). For students who are unable to complete an experimental design, the teacher could provide them with an appropriate procedure to allow students to make observations (refer to Appendix 5.1.3: Teacher's Guide for Acid Precipitation Activity for further detail).
 - Students read a brief synopsis on the impact of acid rain and answer questions.

5.1.3 Investigating Greenhouse Effect

- Students set up control and greenhouse bottles for experiments (refer to Appendix 5.1.4: Teacher Setup for Global Warming Activity for further detail).
- Using a chart (table) and appropriate graph, students communicate gathered observations. An appropriate graph for this activity would be time on the x-axis, and temperature on the y-axis. The table and graph are evaluated.
- Students examine provided picture(s) and write a brief paragraph on the greenhouse effect/global warming.

5.1.4 Investigating Particulate Matter

- Students create particulate collectors (a 2 cm × 2 cm grid covered with a thin layer of petroleum jelly on an index card) and place at various locations at school and/or home several days prior to beginning this investigation.
- Using a microscope, students observe and record the sizes and types of particles collected on their particulate collectors (refer to Appendix 5.1.5: Teacher Setup for Particulate Matter Activity and 5.1.6: Sample Master Form for Particulate Matter Experiment for further detail).
- Students read an article on health-related diseases/concerns of air pollution and suggest one method for them to reduce air pollution.

5.1.5 Investigating the Effects of Car Batteries on Soil

Note: A simulation of car battery acid has been chosen, rather than NiCad or NiMH batteries, because of the potential toxic effects of exposing students to nickel.

- The teacher leads a discussion recalling the concept of pH, acids, and bases from the Chemistry unit. The teacher asks students to recall what they may have learned about chemical batteries, including any dangers.
- Students form a hypothesis regarding the effect on the pH of adding batteries to soil and/or water, and conduct an investigation into the effect on soil and/or water pH by sequentially adding a small quantity of acid (representing the battery) to the soil and/or water. The teacher should provide soil samples to the entire class. A dilute solution of acid, e.g., 0.1 mol/L, should be dispensed into proper volumes, e.g., 10 mL, to represent batteries. Students could use a soil test-kit to measure the acidity of the soil samples provided. Alternatively, if soil test-kits are not available, after allowing the acid sample to be absorbed in the soil, samples could be taken, dissolved in water and shaken, and pH could be measured using universal indicator (refer to Appendix 5.1.7: Teacher Setup for Car Battery for further detail).
- The teacher collects each hypothesis and conclusions for evaluation.
- As a group, with teacher supervision, students brainstorm ideas about what they would need to include if asked to create a one-page flyer to encourage community members to dispose of batteries properly.

Assessment & Evaluation of Student Achievement

See Assessment & Evaluation of Student Achievement in Overview, p. 8.

- In activity 5.1.1, the lab technique and Master Form are assessed for Inquiry and Communication and feedback is given.

-
- In activity 5.1.2, the experimental plan is assessed for Inquiry and Communication using a checklist, e.g., controls, safety, and technique.
 - In activity 5.1.3, the observation table and graph are evaluated for Communication using a rating scale.
 - In activity 5.1.5, the hypothesis and conclusions are evaluated for Inquiry and Making Connections using a rubric.

Resources

Science Resources

Websites

Yucky Fun and Games

– http://yucky.kids.discovery.com/fun_n_games/activities/experiments/experiment_acid_rain.html

Resources for Catholic Teachers

Websites

Eastern Ontario Catholic Curriculum Cooperative – <http://www.eoccc.org>

Faith and the Common Good – <http://www.faith-commongood.net>

Appendix 5.1.1: Progress Chart: Unit 5

Legend:

K/U = Knowledge/Understanding

I = Inquiry

C = Communication

MC = Making Connections

Activity	Task	K/U	I	C	MC
5.1.1	Lab Technique, Observations, and Conclusions				
5.1.2	Experimental Plan				
5.1.3	Table and Graphical Analysis				
5.1.4	Lab Technique, Observations				
5.1.5	Conclusions				
5.2.1	Research on Environmental Concern				
5.2.2	Summary Table: Alternate Energy Generation				
5.3.1	Written report on best alternative energy source for local community In a role as a sales executive for a Green Company selling alternative energy sources, student works to convince local community to eschew fossil fuels (or batteries) and buy the Green Company product. Written submission includes Summary Table of Research on Alternative Methods of Energy Generation and Making Judgements Master Form on pros and cons of burning fossil fuels or using batteries.				
5.3.2	Graphic Organizer of Action Plan				
5.3.2	Action Plan: Written Component				
5.3.2	Action Plan: Oral presentation				
5.3.3	Media Piece for Public Awareness Campaign				
5.3.3	Reflective Questionnaire				

Appendix 5.1.2: Teacher Guide for Oil Spills Activity

Setup:

- A disposable pan, e.g., aluminum, rubber bin, can be set up as a habitat containing water, rocks, plastic fish, feather, fur, boats, etc.
- Oil (any type) is poured on the water to simulate an oil spill.
- Students use various suggested cleaning materials to clean up the objects in the habitat, e.g., paper towel, sponges, cloth, borax, detergents, gauze, cotton balls, mineral oil, detergents and soaps, paper.
- It is suggested that the cleaning materials be provided to each student as a kit, e.g., in a plastic bag or bin.

Discussion:

Possible guiding questions are:

- What cleanup method works best for removing the oil?
- What is the effect of various cleanup methods on wildlife?
- How would this simulation relate to a real oil spill?
- Who are the stakeholders in the oil spill?
- Who would pay for the cost of the cleanup?

Appendix 5.1.3: Teacher's Guide for Acid Precipitation Activity

Note: Since this activity is to be planned by the students, it is suggested that students be given:

- a possible list of materials from which to choose, e.g., test tubes, type of rock, indicator, acid;
- a possible list of headings for their observations chart, e.g., Colour Change, Bubbles, Cloudiness, Sound, Odour.

Some possible suggestions for setup:

- Containers used may be beakers or baby food jars.
- Acids used may be vinegar or dilute hydrochloric or sulfuric acid.

Setup A

- Set up three beakers with lemon juice, vinegar, and water.
- Place one piece of chalk in each of the beakers.
- Observe.

Setup B

- Pour 100 mL of vinegar in three beakers.
- Set up a control using 100 mL of water.
- Completely submerge different types of rock samples of similar quantities, e.g., granite, sandstone, shale, marble, concrete.
- Check for bubbles and cloudiness.

Setup C: same as setup B, but:

- Add indicator and observe colour change.

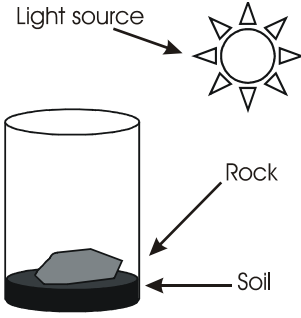
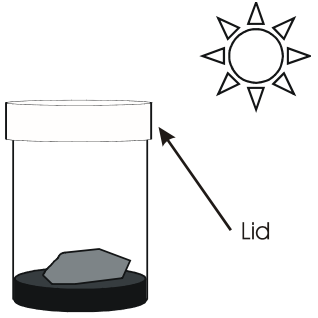
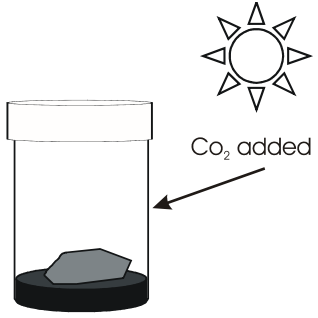
Setup D: same as setup B or C, but:

- Artificial rocks can be made by mixing clay or other soil that is sticky when wet, water, and baking soda. It is formed into 'rocks' by compressing, e.g., one part baking soda, one part sand, two parts clay.
- The clay ball is dried.
- Different amounts of baking soda can be used in the clay – depending on the extent of reaction desirable.

Appendix 5.1.4: Teacher Setup for Global Warming Activity

Setup A

- Set up three clear plastic bottles that have thermometers attached to the side.

		
Bottle 1	Bottle 2	Bottle 3
Contains soil and rock and is open to the outside.	Contains soil and rock and is sealed.	Contains soil and rock and is sealed after CO ₂ is poured in from an artificial source, e.g., tank or baking soda reacting with vinegar.

- Bottle 1 is the control. The other two simulate the greenhouse effect.
- The thermometer is on the side opposite the incandescent source.
- The bottles are exposed to sunlight or an incandescent light source and temperatures are recorded every two minutes.
- Information can be presented as a table or a graph.

Table 1: Observations for temperature change in three bottles

Time (min.)	Temperature (Bottle 1 – control C°)	Temperature (Bottle 2 – greenhouse C°)	Temperature (Bottle 3 – greenhouse C°)
2			
4			
20			

Setup B: same as setup A, but:

- Add soil or water to bottles to simulate habitats.
- Place internal thermometers into soil or water to observe greenhouse effect.

Setup C: same as setup A or B, but:

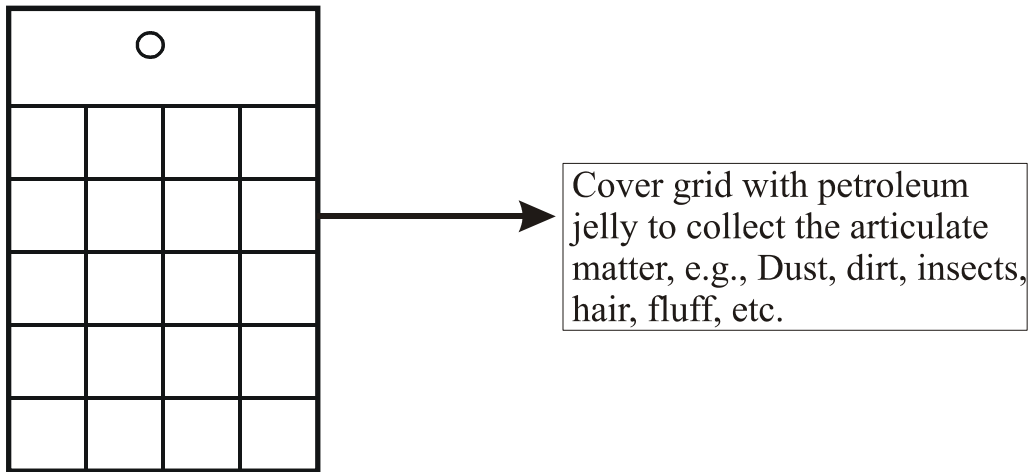
- Use balloons to collect various samples of CO₂ from various sources.
- Set up a fourth bottle with external source of CO₂.

Possible Extension

Give student graph (previously prepared with theoretical data) with unlabelled axis and have them decide which set of data represents the greenhouse effect, i.e., no legend.

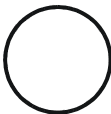
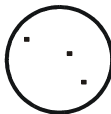
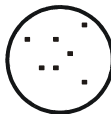

Appendix 5.1.5: Teacher Setup for Particulate Matter Activity

Detecting air pollution instructions (particulate collectors) – index card, with a hole to hang



Appendix 5.1.6: Sample Master Form for Particulate Matter Experiment

Particulate Matter Assessment		Collector #	
Date of setup:		Time of setup:	
Diagram of Location	Wind direction	Height from Ground	
	Description of area		
Possible pollution source(s) in the area			
Position: vertically		horizontally	
Other Notes:			
Date of pickup		Time of pickup	

Level of Particulate Matter				
				
	None	Light	Moderate	Heavy
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Check Appropriate Box				

Other Notes

Appendix 5.1.7: Teacher Setup for Car Battery

Setup A: Testing Effect on Soil

Procedure:

- a) Half-fill a 1000 mL beaker or large plastic yogurt container with soil.
- b) Add 10 mL of 0.1 M hydrochloric acid, sulfuric acid, or vinegar to the soil.
- c) Measure the pH of the soil with soil test-kits, pH paper, universal indicator, etc. If probes are not available, pH paper attached to bamboo skewers or craft sticks can be inserted to various depths, giving the same type of data as a probe.

Setup B

Procedure:

- a) Cut out one side of a milk carton, fill with soil, and insert wooden craft sticks at different heights along the side.
- b) Add 10 mL of the acid until indicator strips change in colour. Each 10 mL of acid represents one more battery added to a landfill site.

Setup C

- a) Set up Petri dishes with paper towels or filter paper moistened by different liquids, e.g., water, vinegar, lemon juice.
- b) Germinate radish seeds (they should germinate within a day or two) and record observations in a table.

Activity 5.2: Media-Based Research

Time: 5 hours

Description

As decision makers of the future, students must consider environmental concerns in the choices they make. Students perform media-based research on the environmental impact of generating electricity. They use skills they have developed throughout the course to choose one of the environmental concerns of interest investigated in Activity 5.1, and investigate how electricity generation impacts their area of interest. Students also collect information to identify a more environmentally friendly power generation method that best suits their community.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills.

Strand(s): Biology: Living Together; Scientific Inquiry: Science in Media;
Physics: Using Electrical Energy

Overall Expectations

BLTV.02 - investigate, using appropriate laboratory and research skills, the implications of organisms existing in communities;

SIMV.02 - investigate science-related information presented in print and electronic media, using appropriate research and reporting skills;

PEEV.02 - investigate the factors that affect the generation and use of electricity;

PEEV.03 - analyse the social, economic, and/or environmental implications of the sources and uses of electrical energy.

Specific Expectations

BLT2.04 - make observations, directly or using technologies, to determine the benefits and challenges of living in communities;

SIM2.02 - research science-related information from a variety of electronic and other sources;

SIM2.03 - interpret research data, including analysis for accuracy and bias as appropriate, using a range of strategies for reading for information;

PEE2.01 - locate and select information from various sources to identify factors affecting generation and use of electricity;

PEE3.01 - compare technologies used for generating electrical energy, including their social, economic, or environmental implications.

Prior Knowledge & Skills

- Knowledge of methods used to generate electricity, both conventional and alternative, from the Physics strand
- Skills developed throughout the course to perform Internet searches for non-biased information and to summarize information
- Knowledge of skills to perform library searches, locate books/newspapers/magazines, and summarize information developed throughout the course
- Ability to draw from information in their notes, portfolios, and observations from Investigation 5.1 that can be used to answer the research-based questions
- Ability to properly cite resources from media-based research

Planning Notes

- The teacher should make arrangements to access a computer lab/resource centre prior to the beginning of this task.
- Instead of viewing a video, students could visit a local science centre or other environmental centre.
- Students may require Internet passwords and library cards in order to access information.
- Teachers should prepare guided questions for students to record relevant information.

Teaching/Learning Strategies

5.2.1 Impacts of Generating Electricity

- As a class, students view video(s) on the topic of environmental concerns studied in Activity 5.1 followed by a class discussion led by the teacher. Refer to Resources for suggestions. Teachers discuss with students the importance of making wise decisions. The teacher could model decision making along with the students, giving perspective on an issue such as purchasing fair-trade coffee. The magazine Ad-Busters is a good resource for this information.
- Students choose the environmental concern that is most relevant/interesting to them based on Investigation 5.1 and the information from the video, and they perform guided media-based research using available resources, e.g., Internet, library, notes, to answer specific questions regarding their environmental concern and the method of energy generation by chemical means that leads to this concern, e.g., coal burning. Students include a properly formatted list of all sources used for their research. Examples of questions used to guide research in this task could include the following:
 - What is your choice of environmental concern?
 - Explain in detail how this environmental concern affects your community (both plants and animals), using examples.
 - Who are the stakeholders in this issue? What might their concerns be?
 - What strategies are presently in place to deal with this environmental concern?
 - What method of energy generation causes or adds to this problem?
 - Describe, in detail, how energy is generated using this method.
 - Where is it practical to use this type of energy generation?
 - Describe the major advantages of this type of energy generation. Consider environmental, social, and economic advantages.
 - Describe the major disadvantages of this type of energy generation. Consider environmental, social, and economic disadvantages.
 - List and describe five ways to reduce your energy consumption within your community.

5.2.2 Researching Alternate Sources of Generating Electricity

- Each student uses a chart to organize and direct their media-based research. The teacher could create the chart to assist the students; headings could include: Type of Alternative Energy Generation, Advantages, Disadvantages, How Well Would This Work in Your Community?
- Using their chart, students individually research alternative methods of energy generation, including solar power, wind power, tidal power, biomass power, geothermal power, and alternative fuels, e.g., ethanol, hydrogen. Students include a list of all sources used for their research in proper format.

Assessment & Evaluation of Student Achievement

See Assessment & Evaluation of Student Achievement in Overview, p. 8.

- In activity 5.2.1, the Summary Table of Research and Making Judgements Master Form is evaluated for Communication, Inquiry, and Making Connections using a rubric.
- In activity 5.2.2, a checklist/rating scale is used to evaluate the summary table for Communication, Inquiry, and Making Connections.

Resources

Science Resources

Websites

Alternative Fuels. EarthTone Video - Environment Canada

– <http://video.durable.gc.ca/video.php?Sequence=4&GroupID=8&lang=e>

Birds Oiled at Sea - Silent Disaster. EarthTone Video - Environment Canada

– http://www.atl.ec.gc.ca/boas/silent_e.html

Environment Canada – <http://www.ec.gc.ca/envhome.html>

Environmental Concerns with Electrical Power Generation

– http://www.wordiq.com/definition/Environmental_concerns_with_electricity_generation

Methane Emissions. EarthTone Video - Environment Canada

– <http://video.durable.gc.ca/video.php?Sequence=3&GroupID=2&lang=e>

Natural Resources Canada – <http://www.nrcan-rncan.gc.ca/inter/index.html>

No Second Chance. EarthTone Video - Environment Canada

– http://www.atl.ec.gc.ca/boas/second_e.html

Pembina Institute – http://www.pembina.org/environmental_edu.asp

Vehicle Emissions. EarthTone Video - Environment Canada

– <http://video.durable.gc.ca/video.php?Sequence=4&GroupID=3&lang=e>

Wind Energy Development Program – <http://windeis.anl.gov/guide/basics/index.cfm>

Video

Endangered Planet. People's Century, 1999, 60 min.

Resources for Catholic Teachers

Websites

Faith and the Common Good – <http://www.faith-commongood.net>

Activity 5.3: Action Plan and Public Awareness Campaign

Time: 9 hours

Description

Students design individual action plans, create a media piece, and participate in a public awareness campaign, highlighting environmental consequences of relying on electrical power generated by burning fossil fuels and/or using chemical batteries. The experimental research completed in Activity 5.1, the media-based research from Activity 5.2, and portfolio materials collected throughout the course allow the student to make decisions on the best method of alternative electricity generation. Students create lists and use them to formulate an action plan. Students share their action plan with their peers to broaden their perspective and to reflect on a variety of methods of making their 'voices' heard. Students could present their course of action in a creative and informative piece to inform their community.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE5d - finds meaning, dignity, fulfillment and vocation in work which contributes to the common good.

Strand(s): Scientific Inquiry: Science in Media; Chemistry: Interactions of Common Materials;
Biology: Living Together; Physics: Using Electrical Energy

Overall Expectations

SIMV.01 - explain how science-related information is presented in print and electronic media for different purposes and audiences;

SIMV.02 - investigate science-related information presented in print and electronic media using appropriate research and reporting skills;

SIMV.03 - evaluate claims and presentations of science-related information in media;

BLTV.03 - analyse the challenges that arise from organisms living in communities;

CIMV.03 - analyse how material interactions affect our daily lives;

PEEV.02 - investigate the factors that affect the generation and use of electricity;

PEEV.03 - analyse the social, economic, and/or environmental implications of the sources and uses of electrical energy.

Specific Expectations

SIM1.02 - discuss, using examples, how the method of presenting information connects to the purpose;

SIM1.03 - explain how different formats used in the media to present science target specific audiences;

SIM2.04 - organize and communicate information collected from lab investigations and information research using graphic organizers;

SIM3.04 - communicate science-related information to a workplace audience by creating a media work;

BLT3.01 - develop an action plan, using a consistent written format, to address an environmental concern;

CIM3.03 - formulate an argument, supported by evidence, to communicate an opinion about the use of a particular material, with consideration for both its physical and chemical interactions;

PEE2.05 - communicate information using appropriate formats for specific purposes and audiences;

PEE3.02 - design and implement a plan to reduce electrical consumption at home, at school, or in a workplace, based on identified consumption patterns.

Prior Knowledge & Skills

- An understanding of different methods of generating electricity
- Experience in researching and safe Internet use
- Knowledge of analysing, synthesizing, and communicating information

Planning Notes

- Student portfolios must be complete with collected evaluated student work and portfolio material from each of the previous strands.
- It is critical for this unit that the work done in the previous activities be evaluated and returned to the students.
- The teacher should arrange the classroom to allow students to work individually and independently.
- Teachers could take this opportunity to lead a discussion with students about considering the common good in decisions, and the importance of long-term planning to meet altruistic goals. Explain that making small choices, such as riding a bike rather than driving, not idling cars, and taking public transportation, can have long-term impacts that are more important than the individual good.

Teaching/Learning Strategies

5.3.1 Making Choices

- Students compile information to make a judgement about the problems and benefits of generating electrical energy by burning fossil fuels or using batteries, using the experimental research completed in Activity 5.1, the media-based research from Activity 5.2, and portfolio materials.
- Students record and organize the information for use in the next task. The teacher may wish to suggest some pieces that should definitely be included, and some that may be included.

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- Individually, students choose one environmentally friendly method of generating electricity appropriate to their community and justify the choice in writing, based on gathered information. The teacher could provide a prompt question, such as: “Using the information you have collected, identify the method of energy generation you think is the best alternative for our local community. Your answer should include information from the lab investigations, from the research you have completed, and your portfolio.”

5.3.2 Plan of Action

- Students design an individual plan of action, consisting of a graphic organizer and a written component, which addresses an environmental concern and details what action(s) can be taken by the student as a concerned member of the community, including suggestions as to how one may get others involved. Suggestions for actions include a petition, a letter-writing campaign, a cleanup campaign, changes in electricity consumption patterns, a ‘greening’ project, and creating awareness through media.
- Students present a brief summary of their action plan in small groups or to the entire class.

5.3.3 Media Campaign

- Students design and create an individual media piece based on their action plan. The media piece could be a rap song, an informational newsletter or brochure, an editorial cartoon, a poster, a video, a speaker’s corner comment, a radio announcement, an elementary school presentation, or other appropriate formats. School supplies and equipment may dictate the nature of the media piece.
- Students defend their choice of format, audience, and message and evaluate the effectiveness of their piece by completing a reflective questionnaire.

Assessment & Evaluation of Student Achievement

See Assessment & Evaluation of Student Achievement in Overview, p. 8.

- In activity 5.3.1, the written report is evaluated using a rubric for Communication and Making Connections.
- In activity 5.3.2, the graphic organizer is evaluated for Inquiry using a rubric. The written component of the action plan is evaluated using a rubric for Making Connections and Communication.
- In activity 5.3.3, the media piece for a Public Awareness Campaign is evaluated for Communication and Making Connections, and the reflective questionnaire is evaluated by a rubric for Communication.

Resources

Science Resources

Websites

David Suzuki Foundation – <http://www.davidsuzuki.org>

Education Place, Graphic Organizers – <http://www.eduplace.com/graphicorganizer/>

The Graphic Organizer – <http://www.graphic.org/>

One Tonne Challenge – <http://www.onetonnechallenge.com>

Resources for Catholic Teachers

Websites

Faith and the Common Good – <http://www.faith-commongood.net>

Appendix 5.3: Rubric for Written Report and Supporting Graphic Organizers (Convincing Town to Switch to Green Energy Source)

Category/Criteria	Level 1 (50-59%)	Level 2 (60-69%)	Level 3 (70-79%)	Level 4 (80-100%)
Inquiry				
- interpret research data, including analysis for accuracy and bias using a range of strategies for reading for information	- interprets research data, including analysis for accuracy and bias using a range of strategies for reading for information with limited competence	- interprets research data, including analysis for accuracy and bias using a range of strategies for reading for information with moderate competence	- interprets research data, including analysis for accuracy and bias using a range of strategies for reading for information with considerable competence	- interprets research data, including analysis for accuracy and bias using a range of strategies for reading for information with a high degree of competence
- organize information collected from research using graphic organizers	- organizes information collected from research using graphic organizers with limited effectiveness	- organizes information collected from research using graphic organizers with moderate effectiveness	- organizes information collected from research using graphic organizers with considerable effectiveness	- organizes information collected from research using graphic organizers with a high degree of effectiveness
Communication				
- communicate information using appropriate formats for specific purposes and audiences	- communicates information with limited sense of purpose and audience	- communicates information with some sense of purpose and audience	- communicates information with a clear sense of purpose and audience	- communicates information with a strong sense of purpose and audience
Making Connections				
- develop an action plan to address an environmental concern	- extends analysis of electrical consumption into a course of practical action with limited effectiveness	- extends analysis of electrical consumption into a course of practical action with moderate effectiveness	- extends analysis of electrical consumption into a course of practical action with considerable effectiveness	- extends analysis of electrical consumption into a course of practical action with a high degree of effectiveness
- communicate science-related information to a workplace audience by creating a media work	- shows limited understanding of the connections between science and the workplace audience	- shows some understanding of the connections between science and the workplace audience	- shows considerable understanding of the connections between science and the workplace audience	- shows thorough understanding of the connections between science and the workplace audience

Note: A student whose achievement is below Level 1 (50%) has not met the expectations for this assignment or activity.